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SAE JOURNAL

JAN 15 1947

This Issue . . .

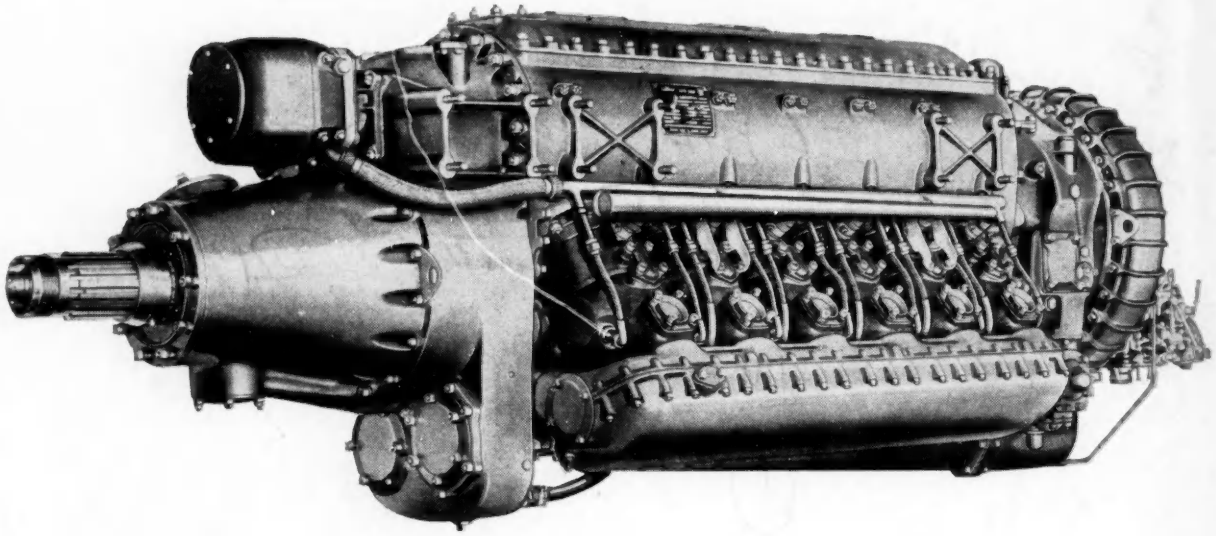
Facts about
NEW SAE OFFICERS

nical Articles on Varied Topics:

Flywheel Vibrations . . . Power Take-off Needs . . . New CAA Rules . . . Industrial Preparedness . . . Supercharger Losses . . . Pulse Jets . . . Air War Lessons . . . and others

R TRANSPORT MEETING
Reported

January 1947



THE CASE OF THE ENGINE That Weighs Only .78 lb. per Horsepower!

Early in 1942, engineers of the Continental Aviation and Engineering Co. completed 10 years of development on a new engine called the Skypower. It was a liquid-cooled, 12-cylinder, 60° inverted V-type engine, weighing but 1,640 pounds.

In the many exhaustive tests that followed, it proved itself to be all they had hoped for—with one exception. They discovered that some of the very factors that increased the efficiency and horsepower of the motor were causing the rings to scuff.

It was found that if the top ring could be prevented from scuffing, the other rings would perform satisfactorily. Perfect Circle developed a steel ring to eliminate breakage, chrome plated the face to reduce scuffing, and incorporated the Keystone cross-section to eliminate sticking, thereby solving the problem and helping to make the Skypower an engine that really lived up to its name!

As a result of this co-operative engineering, the engine was submitted to the AAF for tests and received a war emergency rating of 2,100 horsepower at 3,400 rpm—one of the lightest weight per horsepower engines in modern aircraft development!

This is just one of many examples of how manufacturers can utilize Perfect Circle engineering, facilities and ingenuity to solve tough problems. Perhaps we can help you with *yours*.

PERFECT CIRCLE

PC

PISTON RINGS

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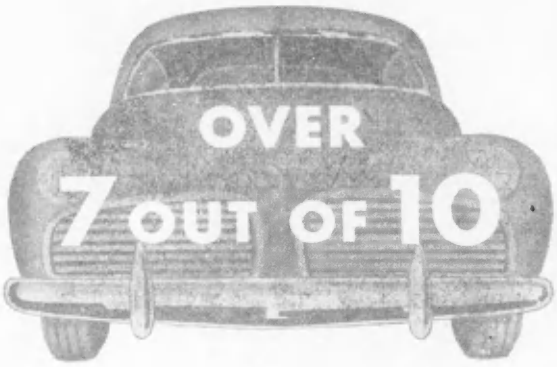
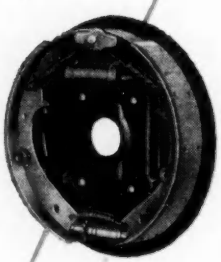


Automotive Vehicles Ever Built have been Better Because of

Bendix Experience

That Bendix is the world's largest manufacturer of automotive brakes is common knowledge in the trade. Bendix engineering experience over the years serves as concrete assurance of better things from Bendix in the future. Expect the best from Bendix —Brake Headquarters for the automotive industry.



Experience is the reservoir of precedent that holds many of the answers to problems of the future, and makes it possible to avoid errors of the past. The most promising plan can go astray in one tiny error that experience would have forestalled. And in the automotive field—where experience is the keystone of success—Bendix* can point to thirty years' cooperation with a progressive industry.

BENDIX PRODUCTS DIVISION, BENDIX AVIATION CORPORATION, SOUTH BEND 20, IND.

*REG. U. S. PAT. OFF.

PRODUCT OF Bendix AVIATION CORPORATION

WHEEL BRAKES
CENTERMOUNT PARKING BRAKE
HYDRAULIC REMOTE CONTROLS
UNIVERSAL JOINTS

Bendix PRODUCTS DIVISION

HYDROVAC* POWER BRAKING
B.K.* VACUUM POWER RELAY VALVES
TRAILER VACUUM POWER BRAKES
HYDRAULIC POWER STEERING

The President's Report for 1946

By L. RAY BUCKENDALE,
President, Society of Automotive Engineers

1946 was a fruitful year for SAE. In every area its activities grew. Attendance at meetings set new records. Publication facilities were expanded. Technical committees completed their most comprehensive program in SAE history. Demands on the Placement Service increased materially. The number of Sections and Groups hit a new high at 38 . . . and for the seventh consecutive year, membership topped all previous years. This full-bodied progress was soundly financed by the largest income and the largest expenditures ever recorded by the Society.

Increased service to members and to industry resulted from this 1946 growth. More national meetings were held; the quality of papers was high. Technical material from the papers was distributed more widely and through more SAE media than in the past. The additional Sections and Groups made SAE associations available locally to an ever-greater proportion of the membership.

Important progress was made in 1946 on all of the projects still unfinished by the Advisory Committee to the Council following its major review of Society organization and operation in previous years (when it was called the SAE Postwar Advisory Committee).

By mid-year it had heard progress reports dealing with streamlining of Meetings Committee organization, revision of membership qualifications, proposed SAE Automotive Progress Lectures, a special educational project, and modernization of the SAE constitution to meet present and foreseeable future needs.

As the year ended, thanks to conscientious cooperation of the Society's regular standing and special working committees, ACTC's extensive portfolio of projects was rapidly nearing completion. Several important projects, however, remain to be studied further during 1947.

Realignment of technical committee work under the SAE Technical Board permitted more effective

Thanks to a Great Team –

As President of the Society of Automotive Engineers for Nineteen Hundred and Forty-Six, I have had the rare privilege of seeing the whole picture of a great live technical society, composed of many men enthusiastically cooperating in all technical fields and adequately served by an intelligent and hard-hitting staff.

Never in SAE history have as many men devoted as much time to the arduous tasks imposed upon them as during 1946.

Expanded technical activity on all of our engineering fronts has called on the finest talent of our membership.

More authors have presented fine technical papers at more SAE national and Section meetings than ever before.

Membership has reached a new high, reflecting devoted effort on the part of the many men from coast to coast who were responsible for this gain.

Administrative problems stemming from the Society's accelerated programs and larger membership have given your Council and committee members a heavy responsibility.

To all of you who have shared in this healthy growth, to you who have devoted costly time and intelligent energy, I extend my sincerest thanks. You have been a great team, and working with you has been a thrilling experience.

L. Ray Buckendale

service to industry and Government than in any previous peacetime period.

How these improvements and expansions were accomplished, present status of the more important projects, and highlights of the problems met and solved during the year are summarized in following pages.

Income and Expenses Pass $800,000 Mark

In the fiscal year ended Sept. 30, 1946, SAE income and expenditures both set an all-time high of more than $800,000. Expenditures were $18,264.27 higher than income.

For the current fiscal year, income prospects appear reasonably bright although present economic uncertainties make specific prediction even more hazardous than usual. Your Finance Committee and Council have built the 1947 budget on the basis of the existing outlook, but have provided for a quarterly review and revision if necessary in the light of changing conditions. They have provided for other contingencies by building up a general reserve which amounted to $442,701.28 at the start of the current fiscal year.

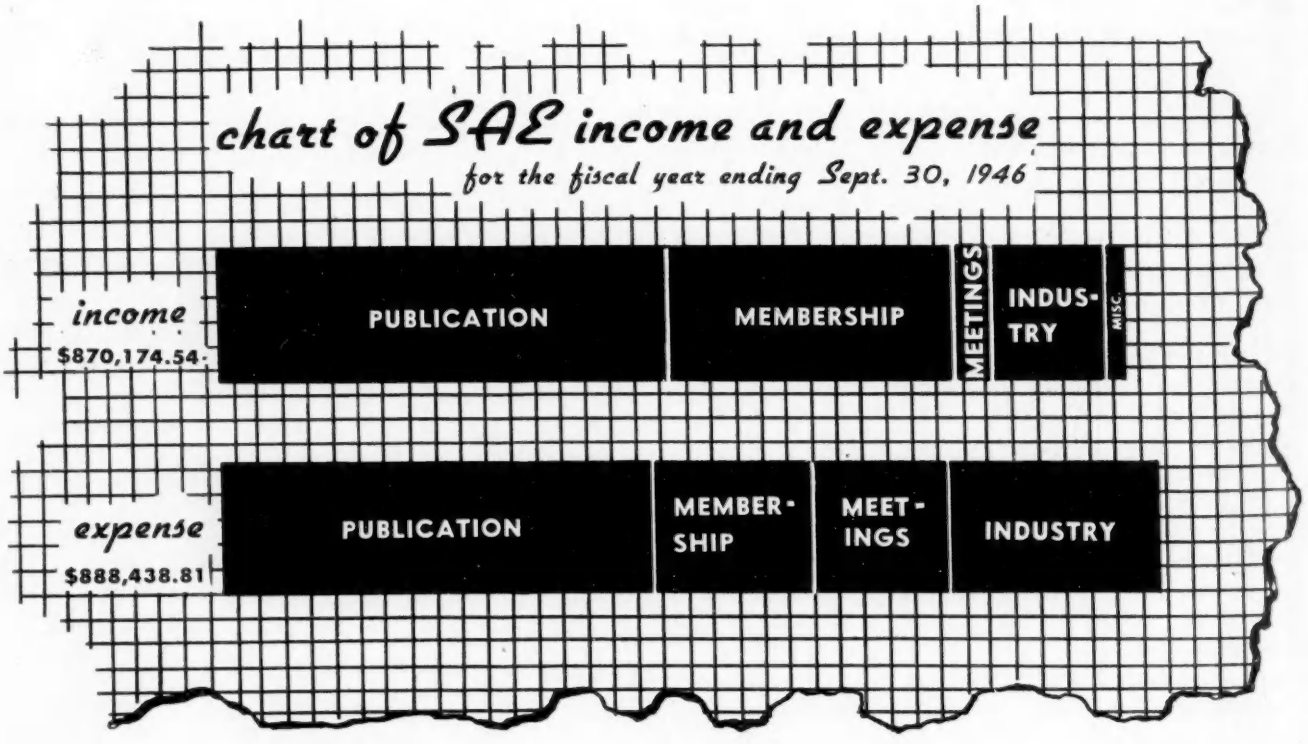
Generally increasing costs and a new high in SAE Journal circulation during the year dictated an increase in advertising rates. The new SAE Journal rates become effective in the 1947 calendar year as old contracts are renewed and new ones obtained. Such increases are in line with the current trend in advertising.

Industry reaffirmed its confidence in SAE by supporting, more generously than ever before, the SAE Technical Committee work for the benefit of industry. This is a highly gratifying appraisal of what has been contributed by the SAE Technical Board and the wide range of technical talent represented on the working committees.

The accompanying chart and financial statement give a summary picture of SAE finances. The excellent condition, as revealed by our audit, testifies abundantly to the sound policies and painstaking planning of the SAE Finance Committee.

Sections and Groups Accelerate Activities

Activities of SAE Sections and Groups expanded during 1946, and the Sections Committee spent a busy year advising the Council in the administration of this growth. Acting through its Executive Committee, the Sections Committee recommended

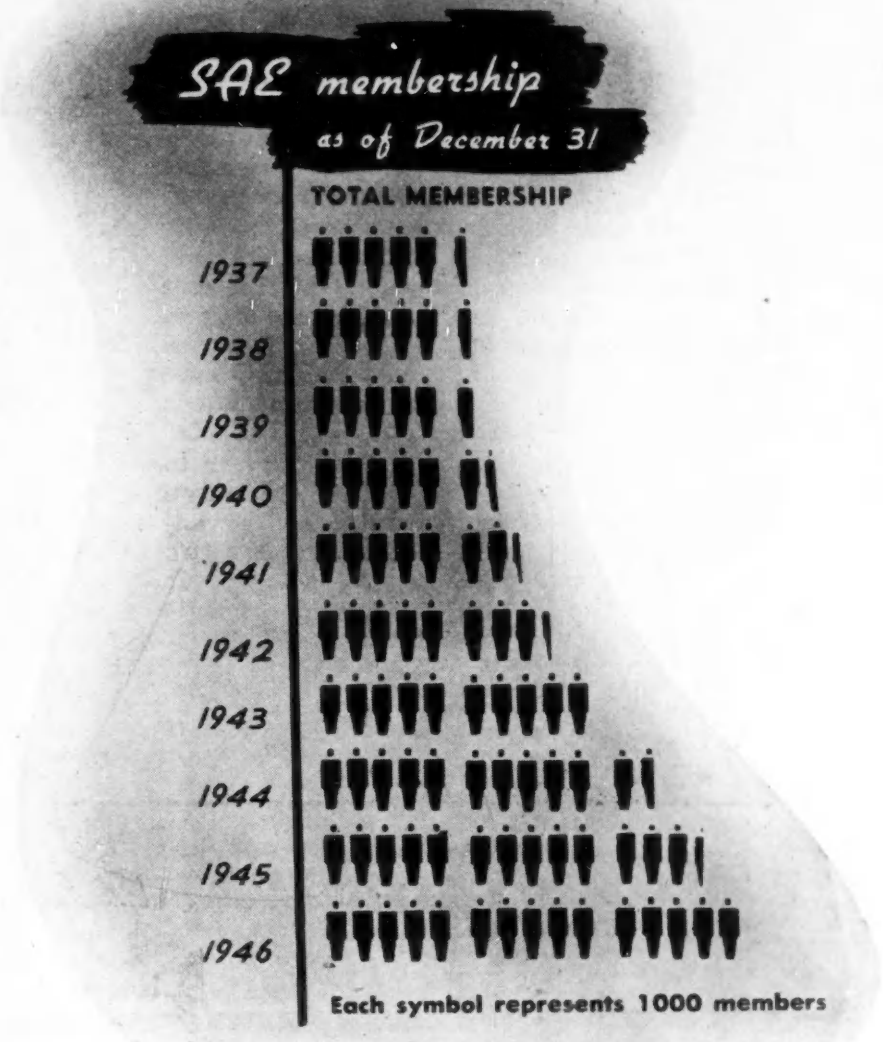


and received Council approval for the formation of the SAE San Diego Section and the SAE British Columbia Group, and the former Twin City Group won recognition as the new SAE Twin City Section. These three actions raised the number of local SAE organizations to 31 Sections and 7 Groups, marking a new high in the scope of the Society's regional activity.

Sections Committee and Council approval also were secured in giving the name of SAE Williamsport Group to the new SAE Group in the area of Williamsport, Pa. Five additional Michigan counties were added to the area of the Detroit Section and a Mid-Michigan Division was established by that Section. Territory of the Syracuse Section was increased to include New York's Steuben County. The Committee and Council also approved change of the name of the Hawaiian Section to SAE Hawaii Section, and authorized the creation of a number of new Section offices to enable local Governing Boards to emphasize specialized fields of particular interest to their Section members. The offices of Vice-Chairman for Aeronautics were approved for the Hawaii and Oregon Sections, and authorization was given for the offices of Vice-Chairman representing Truck and Bus and Diesel Engine for the Southern California Section and Vice-Chairman representing Truck and Bus for the Philadelphia Section.

Principles of Section and Group financial operations came up for study during the year, and with Council approval, the President appointed a special committee to review current procedures. At the year's end this committee's report was not yet complete.

Another important Section topic receiving special attention by the Council is formulation of a workable policy governing SAE Section and Group affiliation with local or regional technical society organizations. A special committee is studying this important policy matter from all angles and soon will submit its recommendations.



Membership Hits a New High — Again!

Throughout the year the Society's membership continued to grow, and this trend was continuing through the closing days of 1946 with the total membership near the 15,000 mark. Thus, for the

seventh consecutive year, there were more SAE members than in any previous year in the Society's history.

Despite the dislocations of industrial reconversion and other factors which would cause men to defer applying for membership, the total number of applications received during the year exceeded last year's 2234. Inasmuch as fewer than 750 members left the Society during 1946 because of death, resignation, or cancellation, the ratio of members gained to members lost was decidedly favorable.

End-of-the-year prospects were for a continuing influx of new membership applications at about 75% higher than the prewar rate. At the same time, it is hoped, the major part of the process of relocating engineers in peacetime pursuits was completed in 1946, and fewer members will leave the Society because of changing their occupations to work outside the Society's scope.

A new booklet was issued during the year to acquaint prospective members with the Society's facilities. More detailed than previously available descriptive matter, it outlines the Society's aims, activities, and membership privileges. It was distributed to the SAE membership committees, and is available from the Society's Headquarters upon request.

Student Activities

A sharp upturn in SAE Student Enrollment characterized the end-of-the-year trend of this special SAE affiliation for students in engineering colleges. With returning veterans setting registration records at technical schools, new applications for SAE Enrollment were more than 50% ahead of the 1945 figures, and engineering students were inquiring into every phase of the Society's program.

A number of SAE Student Branches which had suspended operations during the war were reactivated and new schedules of meetings, plant inspection trips, and a variety of technical and social functions were put in motion. In addition, students at a number of engineering colleges where there had been no previous SAE activity applied for SAE Student Enrollment and made active use of the SAE benefits which became available to them.

The faculty advisors of SAE student organizations gave generous and effective guidance to the Society's Clubs and Branches. Their recommendations to the Student Committee, moreover, were of great aid to the Society in its resolve to increase the value of its student program.

Growth in National Meeting Sessions and Papers

year	No. of meetings	No. of sessions	No. of papers
1941	7	64	118
1942	7	52*	102*
1943	9	73	146
1944	10	97	185
1945	**	**	**
1946	11	112	226

*Drop caused by sudden cancellation of Summer Meeting.

**Figures not significant; seven National Meetings cancelled because of meetings ban.

Meetings Set New High In Papers, Attendance

Completely freed from wartime bans and restrictions, SAE national meetings came back into their own in 1946 and set new attendance records all over the country. The return of the Summer Meeting and the National Production Meeting (both of which were wartime casualties), together with an unusual number of outstanding exhibits, highlighted the 1946 schedule.

Eleven national gatherings were held in 1946 – with a total attendance close to the 10,000 mark. Record-breaking audiences listened to more than 226 papers and speeches – as against 185 in 1944; 146 in 1943; and 102 in 1942. Total number of sessions was up 15% in 1946 over 1944. (Seven national meetings were cancelled in 1945.)

Meetings Committee plans for 1947, now nearing completion, will provide an even larger technical paper program than in 1946. The 1947 Annual Meeting, being held as this report comes off the press, has already eclipsed the all-time record of papers set last year, and bids fair to exceed the attendance record.

Additions and changes in process for the 1947 national meetings schedule envision a considerably increased participation by passenger car, truck, bus, and personal aircraft interests – and a continuance of the high-level operations of other Activity meetings groups.

The first postwar Summer Meeting was held at French Lick Springs, Ind., and attracted a large and enthusiastic crowd. The 1947 Summer Meeting will be at French Lick as well. (White Sulphur Springs, site of many successful prewar summer gatherings, will not be in civilian operation again in time to be SAE's 1947 host.)

Publications Expand To Meet Member Needs

SAE publication facilities have been expanded to keep up with the vastly increased amount of technical material being developed by SAE meetings and technical committees. Result of nearly two years study by the Publication Committee and the SAE Council, the expansion program is now virtually completed. In 1947, the revised SAE Journal and the new SAE Quarterly Transactions will bring members some 800 pages more per year of papers and technical information than in the past. With each publication aimed at specific objectives, duplication of data will be at a minimum and reprinting of material practically eliminated.

Under the new program, SAE Quarterly Transactions is designed to emphasize papers and material of relatively lasting value and usefulness, and completeness of presentation to the extent of making available the information needed or desired by the specialist. The SAE Journal is now designed to lay stress on timely material, handling and briefing material as necessary to interest as many as possible of SAE's more than 15,000 member readers. It will aim at maintenance of as good balance of SAE interests as possible in every issue.

The first issue of SAE Quarterly Transactions will be in the mails on Jan. 20, 1947. The SAE Journal has appeared since last October in its revised form.

A yearly index to the SAE Journal will be published separately and made available upon request, as in the past, while in the fourth (October) issue of SAE Quarterly Transactions will be bound a complete index of that publication for that year. To simplify the latter index, the SAE Quarterly Transactions pages will be numbered consecutively throughout the four volumes of each year.

SAE Special Publications

SAE Special Publications Department, completing its second year of operation, continued and expanded its supplementary service to thousands of SAE members and to industry and engineers generally. During the past 18 months, more than 125,000 copies of hundreds of different SAE engineering reports and technical papers have been distributed by the department.

This is the sum of more than 50,000 copies of a dozen SAE technical committee reports covering a variety of automotive subjects, and more than 75,000 copies of several hundred SAE meetings papers.

Expansion of the Special Publications Department has resulted in greatly increased service to SAE members.

Public Relations

Policies and practices designed to maintain good public relations for the Society have been established by the SAE Public Relations Committee (newly organized in 1946) and implemented by the staff. Some objectives include publicizing SAE work and accomplishments for better and more general understanding of SAE among persons influential in industry, the press, public life, and education. Special attention has been given to the problem of interpreting SAE work to the public and press in ways which suggest the importance of that work to automotive engineering progress and, consequently, to the welfare of the American public.

Technical Committees Complete Big Program

The most comprehensive peacetime program of technical committee activity in SAE history got under way and produced notable results in 1946 – the first full year of operation of the SAE Technical Board created in September, 1945. Necessary reorganizations in SAE Technical committee structure for operation under the Board were effected smoothly and without interfering with the continuity of the work.

Only a list of the standards, recommended practices and technical reports approved by the Board would portray fully the work completed by SAE technical committees during the past year. A bare listing of these reports would fill several pages and since each has been announced at the time of issue in the monthly issues of the Journal, it seems unnecessary to present the entire list here. Each of the technical committees is actively engaged on numerous projects and members are being kept informed of their activities through the "Technical Committee Progress" pages of the SAE Journal.

Organization-wise, the Board has integrated and simplified the technical committee structure, is taking steps to make Society participation more effective in the committees of other organizations such as ASA and ASTM, and is developing plans for peacetime cooperation with the Army and Navy.

At present, there are 22 committees reporting directly to the Board. Most are successors to the former divisions of the General Standards Committee, to former committees under the General Research Committee and to former special technical committees. The current list of committees is as follows:

Aeronautics
Ball and Roller Bearings
Brake
Bumper Height Standards
Commercial Vehicle Nomenclature
Electrical Equipment
Fuels and Lubricants
Highways Research
Iron and Steel Technical
Lighting
Motorcoach and Motor Truck
Non-Ferrous Metals
Non-Metallic Materials
Parts and Fittings
Passenger Car Body
Porous Chrome Plating
Riding Comfort Research
Screw Threads
Spring
Tractor Technical
Transportation & Maintenance Technical
Torsional Vibration

The following committees are in the process of organization:

Automotive Engine
Automotive Drafting Practice
Motorboat Hubs, Shafts and Couplings.

The Board has maintained active relationships with Government agencies during the year and is making special studies looking to the development of effective plans for peacetime cooperation with the military. A number of recommendations on AN Aeronautical Standards have been developed for the use of the Aircraft Industries Association and of the Working Committee of the Aeronautical Board. Technical committees have rendered advisory assistance to both the Army and the Navy, as well as to such civil organizations as the Interstate Commerce Commission and the American Association of Motor Vehicle Administrators.

The affairs of the Board are conducted under a simple set of rules and regulations which the Board adopted at its second meeting. These rules and regulations, which are consistent with the authority and responsibility delegated to the Board by the Council, are printed in full in the SAE Handbook. In addition, a number of committees operating under the Board are developing rules and regulations to define their own procedures.

Placement Service Meets Postwar Needs

Since the cessation of hostilities a year ago, the Placement Service has been an active registration center of those members who are available for a change of position either due to the cancellation of war contracts, return from service or a change in business trends. At the present time the men on the "Available" list number more than 500, a figure higher than for some years.

In contrast to the high rate of registration, the number of positions being listed is lower than it has been for some time. Applicants find the companies tied up with strikes, labor disputes, forced holidays and employers reluctant to make final decisions about employment problems until they are certain that they will be able to carry them out. Housing difficulties have also been instrumental in the inability of employer and applicant to come together.

The Service continues, however, to issue 11 different categories of "Men Available" bulletins, two each week in rotation, to approximately 300 companies on the mailing list. In addition, a monthly bulletin of "Positions Available" is sent to all members registered, as well as to the Sections Placement Chairmen. The latter have been most helpful in bringing positions and applicants together in their respective Sections.

A folder describing the Service has been prepared and is available on request to the Placement Service at SAE headquarters in New York.

BALANCE SHEET

As At Sept. 30, 1946

In Agreement with Haskins & Sells Audit

Assets		
Cash—Unrestricted	$ 46,141.15	
SAE War Chest	.....	
Restricted		14,644.23
Notes & Accounts Receivable—Net		24,727.62
Securities		397,469.00*
Accrued Interest on Securities		2,603.92
Inventories		849.05
Deposits		475.00
Furniture & Fixtures		1,000.00
Deferred Charges		38,746.05
Total Assets		$526.656.02

Liabilities & Reserves	
Accounts Payable	$ 11,364.53
Members' Dues Received in Advance	36,379.75
Deferred Credits to Income	12,736.55
Reserve for Unexpended Contributions	10,557.33
SAE War Chest	.....
Reserve for Retirement Plan Contributions	12,916.58
General Reserve	442,701.28
Total Liabilities & Reserves	$526,656.02
Accounts Receivable—Member Dues September 30, 1946	$ 790.00

* Book value (9/30/46). Quoted Market or Redemption Value $391,546.07.

During 1945-46 $48,977.99 was transferred from the SAE War Chest to General Reserve thereby closing the War Chest Account.

INCOME AND EXPENSE

12 Months Ending Sept. 30, 1946

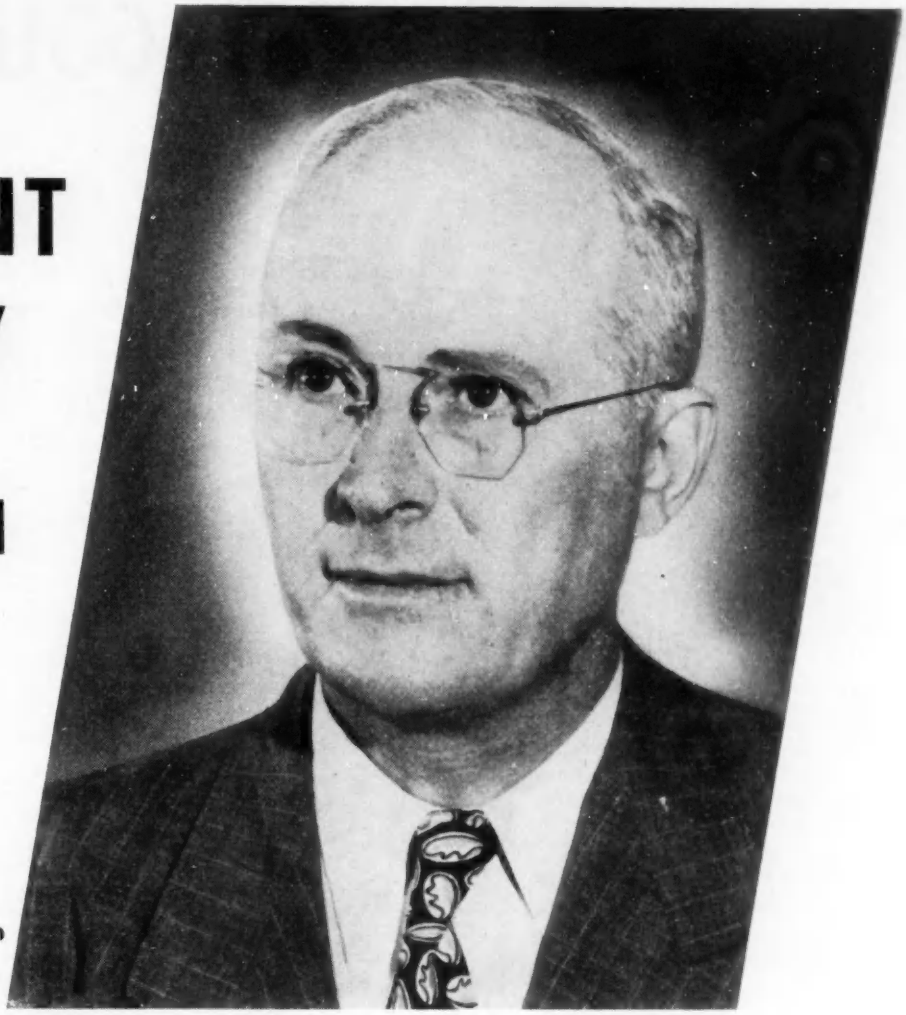
In Agreement with Haskins & Sells Audit

Income		
Membership		
Dues Earned	$163,702.50	
Subscriptions Earned	66,976.00	
Initiation Fees	39,040.00	
Miscellaneous Membership Income	1,354.85	$271,073.35
Publications		
Journal Sales	13,345.00	
Journal Advertising	339,788.50	
Handbook Sales—1945-46	9,038.17	
Handbook Advertising—1946	14,750.00	
Transactions Sales—1943-45	15,088.00	
Aeronautical Publications	16,292.34	
Special Publications	23,309.55	
Miscellaneous Publications	3,684.13	435,295.69
National Meetings		
Guest Registrations	2,286.50	
Dinners & Luncheons	19,110.40	
Display—Detroit	9,085.00	
Summer Meeting	6,975.50	37,457.40
Industrial Income for Technical Board Services		116,100.60
Interest & Discount		
Interest Earned	9,920.63	
Discount Earned	326.87	10,247.50
Total Income		$870,174.54

Expenses		
Sections and Membership		
Sections & Student Branches	$ 16,263.43	
Sections Appropriations and Dues	42,151.74	
Membership	27,038.54	
Placement	6,123.38	
West Coast Office	16,457.05	
Miscellaneous Membership Expense	7,241.36	$115,275.50
Pro-Rated Administrative Expense (16.8%)		33,311.96
		148,587.46
Publications		
Journal Editorial	96,015.85	
Journal Advertising	117,389.60	
Handbook Editorial	30,329.40	
Handbook Advertising	3,175.66	
Transactions—1943-45	22,660.11	
Aeronautical Publications	19,879.40	
Special Publications	16,217.65	
Miscellaneous Publications	13,043.74	318,711.41
Pro-Rated Administrative Expense (46.2%)		91,607.89
		410,319.30
National Meetings		
Departmental Expense	30,742.48	
Meetings	37,170.60	
Dinners & Luncheons	17,805.48	
Display—Detroit	7,199.04	
Awards	708.25	93,625.85
Pro-Rated Administrative Expense (13.5%)		26,768.54
		120,394.39
Technical Board Services		
Technical Committee Operations	113,823.63	
Engineering Relations	5,445.13	
CRC Appropriation	35,000.00	154,268.76
Miscellaneous Expense		8,094.92
Pro-Rated Administrative Expense (23.5%)		46,597.08
		208,960.76
Total Direct Expenses	689,976.44	
Total Administrative Expenses	198,285.47	
Loss on Sale of Securities—Net	176.90	176.90
Total Expenses and Loss		888,438.81
Operating Deficit/Net Income		—18,264.27
Total Income		$870,174.54

PRESIDENT for 1947

C. E. FRUDDEN



SAE's 1947 President-elect, Conrad Erwin Frudden (pronounced Froo-den), hitched his wagon to a tractor and literally grew with the American tractor industry. As a boy he helped to survey the site of one of America's first tractor - manufacturing plants. As high school and college student, he spent his vacations working in tractor plants. After graduation from college, he became a tractor engineer – his profession today, as consultant for the Tractor Division of Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Frudden was born at Ossian, Iowa, March 1, 1887, and was reared at Charles City, Iowa. There he met President C. W. Hart, of Hart-Parr Co., then a 25-year-old mechanical engineer pioneering in the design and manufacture of tractors. Hart now generally is regarded as the first American to have built a practical, salable farm tractor and to have founded the tractor industry.

Hart, helped by the hero-worshiping 14-year-old Frudden to survey the site of Hart-Parr's Charles City tractor-manufacturing plant, now The Oliver Corp., advised the youngster to plan to study mechanical engineering at Iowa State University as the more direct route to a course in tractor technology. Frudden received the degree of Bachelor of Science in Mechanical Engineering from Iowa State in 1909, and went on to advanced engineering studies at Columbia University.

Since 1910 Frudden has held executive engineering positions successively with Hart-Parr; with Parrett Tractor Co., Chicago, Illinois; with the Buda Co., Harvey, Illinois; and with Allis-Chalmers at Milwaukee. He became chief engineer of the Allis-Chalmers Tractor Division in 1929. He has traveled throughout the United States and Canada, studying tractor operations on farms and working out tractor engineering requirements. He now holds several patents covering tractor design, engine accessories, and other farm machinery.

During World War I, Frudden served as captain, Motor Transport Corps. In World War II, he was for one year consultant for the War Production Board's Farm Machinery and Equipment Branch.

An SAE member since 1917, President-elect Frudden long has been active in the work of SAE technical committees and leader in the affairs of the SAE Milwaukee Section. He served as SAE vice-president and chairman of the Tractor & Industrial Power Equipment Engineering Activity in 1938. He served SAE Milwaukee Section as treasurer in 1933, as vice-chairman in 1934, and as chairman in 1935. He has been member of technical committees of SAE Fuels & Lubricants and Diesel Engineering Activities, and of various divisions of the SAE General Standards Committee.

He is particularly proud that many of his younger associates have become actively interested in SAE affairs. Four have served as chairman of the Milwaukee Section.

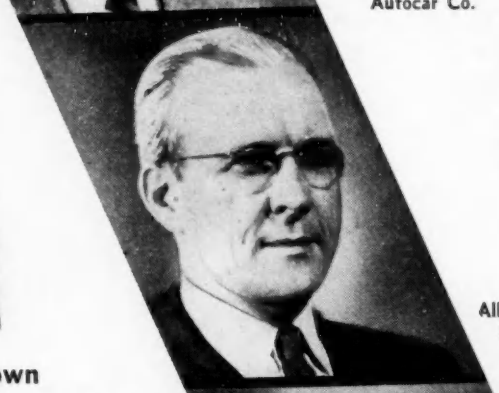
Frudden is member and counselor of the American Society of Agricultural Engineers. He was married in 1925 at Fairmont, Minnesota, to Hazel Rowley, and with his wife, son, and daughter resides at 604 Crescent Court, Milwaukee.

SAE COUNCILORS

Treasurer
B. B. Bachman
Autocar Co.

Marcus L. Brown

Councilor Marcus L. Brown, Jr. (M '29), comes from Ontario, where he is president of Seiberling Rubber Co. of Canada, Ltd. Born in Georgia, he received his BS in mechanical engineering from Georgia School of Technology, and held his first job in Atlanta – time study engineer for Atlantic Steel. After five years with Goodyear Tire & Rubber Co. in Akron, he became successively production engineer, assistant superintendent, factory manager and vice-president in charge of production for Seiberling. He assumed his present position in 1945.



Albert J. Blackwood
Standard Oil
Development Co.

Elmer McCormick

Councilor Elmer McCormick (M '17) has been with John Deere Tractor Co. since his student days at the University of Illinois. During that time he has risen from draftsman to chief engineer.

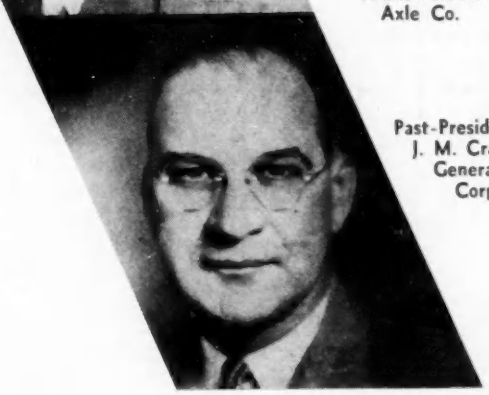
McCormick was 1937 vice-president representing Tractor & Farm Machinery Activity, and has worked extensively in SAE standardization on parts and fittings, tires and rims, and lubricants.

A. E. Raymond
Douglas Aircraft
Co., Inc.

Past-President
L. Ray Buckendale
Timken-Detroit
Axle Co.

C. H. Miller

Councilor C. H. Miller (M '37) was first associated with White Motor Co. in 1926 as a technical student, and is now its export service manager. During the war he was loaned to Army Ordnance. Then came an assignment in White's Philadelphia Branch. He returned to Cleveland in 1945. He was Sections Committee chairman in 1944 and 1945, Cleveland Section chairman in 1942-43.



Past-President
J. M. Crawford
General Motors
Corp.

VICE-PRESIDENTS

Harold R. Harris
Vice-President, Air Transport Activity

Harold R. Harris (M '22), vice-president and general manager of American Overseas Airlines, Inc., began his flying career in 1917 at the School of Military Aeronautics in Berkeley, Calif. Returning from overseas bombing operations, he served for seven years as test pilot and chief of flight test research for the Army Air Corps. In 1926 he was the holder of 13 world flying records.

Harris' airlines career started in 1928 when he became vice-president and general manager of the Peruvian Airways Corp. From 1929 until 1942, when he entered the Army Air Transport Command, he was vice-president and chief operations officer of Pan-American Grace Airways. With the ATC he served as assistant chief of staff, plans; assistant chief of staff, operations; commanding officer of the Domestic Transportation Division; and finally ATC chief of staff with the rank of brigadier-general.

He has received the Distinguished Service Medal, the Legion of Merit and the Air Medal.

J. M. Shoemaker
Vice-President, Aircraft Activity

J. M. Shoemaker (M '30) received his B.S.M.E. from Purdue in 1925, spent two years as junior aeronautical engineer for NACA, and then took his B.S. in aeronautical engineering from M.I.T. During the next three years he was assistant aeronautical engineer for Pratt & Whitney Aircraft, designer for Engineers Aircraft Corp., and a lecturer at the University of Southern California. After three years with NACA as assistant aeronautical engineer, he joined Chance Vought Aircraft Division of United Aircraft Corp., where he is now chief engineer.

Shoemaker has been active in the Aircraft Activity Committee, and served as its vice-chairman in 1944.

Carl T. Doman
Vice-President, Aircraft-Powerplant Activity

Carl T. Doman (M '26) has brought his extensive experience in the aircraft powerplant field to the writing of 16 published papers on the subject. A graduate of Rensselaer Polytechnic Institute and the University of Michigan, he worked for Dyneto Electric Co. and H. H. Franklin Mfg. Co., and in 1935 became a partner in Aircooled Motors Corp. (formerly Doman-Marks Engine Co.). He is now vice-president, director, and chief engineer of the corporation.

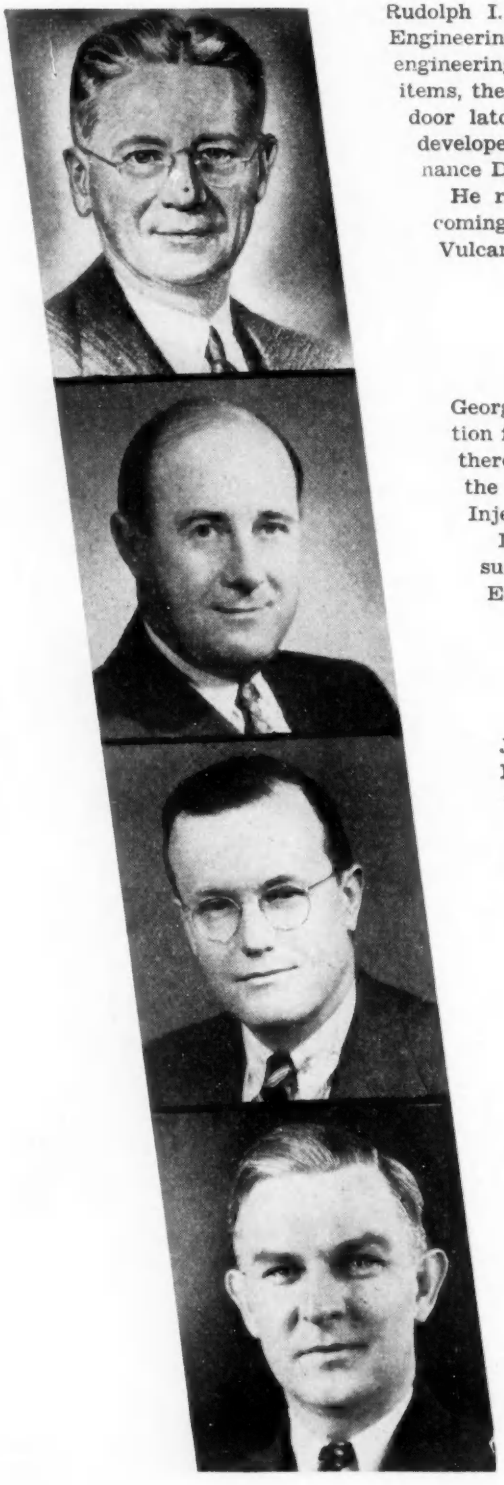
In addition to his SAE activities, he is an associate fellow of the Institute of Aeronautical Sciences, a charter member of the American Helicopter Society, and a member of the American Society for Engineering Education and the National Metal Trades Association.

Harold R. Harris

J. M. Shoemaker

Carl T. Doman

VICE-PRESIDENTS



Rudolph I. Schonitzer
Vice-President, Body Activity

Rudolph I. Schonitzer (M '15) is founder and chief executive of the Schonitzer Engineering Co., organized in 1932 to develop automotive products and to furnish engineering and management services to industry. He has originated, among other items, the door support, door-holding-type door check, and the push-button-operated door latch. During World War II, his engineering organization originated and developed many war materiel items for which Schonitzer was cited by the Ordnance Department.

He received his education and served his apprenticeship in Hungary. Since coming to this country in 1911, he has been associated with the Moline Plow Co., Vulcan Car Co., Allen Motor Co., Truscon Steel Co., and Auburn Automobile Co.

George M. Lange
Vice-President, Diesel Engine Activity

George M. Lange (M '29) joined Timken Roller Bearing Co. after his graduation from the College of Engineering of the University of Minnesota. He served there in various engineering and sales capacities until 1942. In 1944 he joined the Ex-Cell-O Corp. in his present capacity of project engineer in the Fuel Injection Division.

In his many years of service to SAE Milwaukee Section, Lange has been successively treasurer, secretary, meetings committee representative, Diesel Engine Activity chairman, meetings chairman and vice-chairman.

John M. Campbell
Vice-President, Fuels & Lubricants Activity

John M. Campbell (M '37) has been research engineer with the General Motors Research Laboratories since he got his B.S. in chemical engineering from M.I.T. in 1925. His principal activities have been in the field of combustion and performance properties of motor fuels in automotive engines. He has also participated in the program of the Coordinating Fuel Research Committee in the development of test procedures for evaluating detonation and vapor lock in automotive equipment, and has contributed to solution of Ordnance Department problems of fuel and lubricant utilization in military equipment through his activities with the CRC War Advisory Committee. Campbell is also a member of ASME, the American Chemical Society, and the Engineering Society of Detroit.

William H. Graves
Vice-President, Passenger Car Activity

William H. Graves (M '24) became Packard Motor Car Co.'s executive engineer in 1945. He joined Packard immediately after receiving his B.S. from Michigan in 1919. In his 28 years with the company, he has been responsible for introducing numerous major improvements in manufacturing processes. During the war, he was assigned the task of writing specifications for American materials used in the British Rolls-Royce aircraft engine manufactured by Packard. Specifications on 12,000-odd parts of the intricate engine were changed over to American standards, made to conform to rigid standards of the United States and the British Air Corps.

In addition to his SAE activity, he is a member of the ASTM, American Society for Metals, and Engineering Society of Detroit.

VICE-PRESIDENTS

Stephen Johnson, Jr.

Vice-President, Production Activity

Stephen Johnson, Jr. (M '30), is assistant sales manager of Bendix-Westinghouse Automotive Airbrake Co. He previously served on the SAE Council as Vice-President representing Truck & Bus Activity in 1937. He has been active in Bendix-Westinghouse engineering ever since he graduated from college in the early '20s. His only other business association was as an apprentice machinist with Newport News Shipbuilding & Drydock Co. before he entered the University of Michigan. He has served Bendix-Westinghouse as service engineer, general engineer, chief engineer, and manager of sales engineering.

Active in SAE ever since he joined the Society, Johnson has been a member of many technical committees, among them the Brake Committee and several standards committees. He has been a member of the Production Activity Committee for many years.

Ben G. Van Zee

Vice-President, Tractor & Farm Machinery Activity

Ben G. Van Zee (M '38) received his early training in the farm machinery field in his father's implement business. He was graduated from Iowa State College in 1922, and obtained his master's degree in agricultural engineering in 1930 from the same institution. During this period he spent some time in the farm machinery field, and also worked as an agricultural engineer in Central America for the United Fruit Co.

Van Zee joined Minneapolis-Moline Power Implement Co.'s engineering department in 1930, and in 1936 was made assistant chief engineer. In 1944 he assumed his present position of chief engineer in charge of design on all tractors and industrial engines.

Donald K. Wilson

Vice-President, Transportation & Maintenance Activity

Donald K. Wilson (M '27) has been superintendent of automotive equipment for the New York Power & Light Corp. since 1929. After receiving his mechanical engineer's degree from Cornell in 1925, he joined Aluminum Co. of America as a research assistant. During the next three years he was transportation engineer, assistant superintendent of transport, and finally superintendent, for the Utica Gas & Electric Corp. During the war, Wilson was chairman of the SAE Ordnance Vehicle Maintenance Committee, and a member of the SAE-ODT Coordinating Committee and the War Advisory Committee.

Schuyler A. Jeffries

Vice-President, Truck & Bus Activity

Schuyler A. Jeffries (M '23) has been with Studebaker Corp. for over ten years as chief engineer of the Truck Division. During the war years he was very active in developing many types of special transport equipment to be tested by the Motor Transport Division of the Army. Four types of 4x6's and 6x6's were accepted by the Ordnance Office, and Studebaker's Truck Division produced over 197,000 of these vehicles.

After completing his education at Michigan State College, Jeffries worked with Oldsmobile, Amplex, and Apperson before starting an 18-year career with Reo. There he worked on both passenger cars and trucks, becoming finally head of the truck engineering department. Then, following a brief period with Stutz, he joined Studebaker. He has served on many SAE technical committees and has long been a member of the Truck & Bus Activity Committee.

PREPAREDNESS

PEARL HARBOR, now nearly five years ago, is indelibly imprinted upon the memories of all of us. The rapid extension of speed and range of airplanes and pilotless missiles will make surprise through the air the normal method of initial attack in any future war. It may be that by the simple adjustment of a set screw on an atomic rocket, an enemy could bring into range any one of our great industrial centers.

With these awesome facts in mind, upon what base can we build our security? Gen. Carl E. Spaatz, commanding general of the Army Air Forces, stated "We of the Air Forces believe that the first requirement for planning and seeking the world we want is national strength – strength which is obvious to other nations. The first element of national strength is armed-strength-in-being."

A basic factor in the development of our national strength is a program of national industrial preparedness. In so far as the air forces are concerned, peacetime industrial preparations must be made to maintain air power superior to all. The security of this country is dependent upon successful Air Industrial Preparedness Planning. And the success of Air Industrial Planning is dependent upon representative groups of private citizens, such as the Society of Automotive Engineers.

Air Industrial Planning is the first milestone on the road to American security.

Today we are concerned over the time element regarding aircraft production during wartime. Our concern over the time required in World War II to reach volume production of aircraft is more than justified. Particularly, it is justified when one considers that in two World Wars, allies have held our enemies in check until America could convert to war-winning production. In each instance, American production tipped the scales toward victory. It is doubtful if any future aggressor will forget this. For our own good, we must not forget it.

An approach to industrial mobilization by American aircraft manufacturers came in 1938. As you may recall, representatives of the French Government contracted for tactical aircraft equipment. They were convinced that war was inevitable. By 1939, when Hitler attacked Poland, we had delivered approximately 500 aircraft to France.

Until the Nazi blitz in Western Europe, America showed little sign of realizing that war was practically at our doorstep.

World War II aircraft production record is familiar to all of us. When the President in June, 1940, called for 50,000 planes, we were producing at an annual rate of only about one-tenth this figure. Then we rolled up our sleeves and went to work. In the year and a half to December, 1941, aircraft production increased six fold. By one year later when we invaded North Africa our production rate had tripled, and in the next year and a half to Normandy D-Day, there was another three-fold increase. In the record year 1944, we produced some 96,000 military airplanes, with an airframe weight of 1,000,000,000 lb. This contrasts with the first six months of 1946 when our military aircraft production was at an annual rate of only about 15,000,000 lb. However, the attainment of these seemingly astronomical production goals during the war years was reached only by the vast expenditure of materials, manpower, management, and money, stretching over a five-year period.

Author . . .

AAF's Brig.-Gen. John C. Gordon, a veteran of China-Burma-India front

It is this time element about which we are concerned for the future. So much has been said and written about this production miracle that we may have overlooked the fact that miracles take time. In planning for the future, certain fundamental facts of World War II experience stand out: The average time lag from Government go-ahead until the contractor reached volume production on a plane model was three and a half years.

The time from starting construction of a new plant until the first airplane was produced averaged one and one-half years.

The automobile industry as licensees produced 60% by 1944, but to attain this production peak on engines required approximately three years.

Finally, every plane and every engine which saw combat service was on the drawing board in varying stages of design prior to Pearl Harbor.

Guarantees SECURITY

BY **Brig.-Gen. John C. Gordon***

These facts challenge us in planning our military aircraft program for any future emergency. We actually prepared ourselves industrially for this last war by what is called the "old swimming hole method." You wait until you are pushed into the water, and *then* you see if you can swim.

. . . Speaker

Major-Gen. Edward M. Powers, deputy assistant chief of Air Staff, AAF

During the past war, I served over a year and a half as Chief of Plans and Operations for the China-Burma-India Army Air Forces. One of our most powerful and versatile planes was the B-25 "Billy Mitchell" medium bomber. You may also remember this plane as the one chosen by Jimmy Doolittle for his sensational raid on Tokio in April, 1942.

As I watched these planes take off every day, it was hard to realize what a long road there had been on the design, engineering and production line before these fine planes became available for combat.

North American's B-25 was one of many designs submitted under the competitive Air Corps Circular issued in March, 1939. The first B-25 was completed, flight tested, and accepted within a period of 17 months. By the time of Pearl Harbor, approximately 130 operational B-25's had been produced.

In 1942, the Inglewood plant averaged nearly 100 per month, and a peak of 148 B-25's were produced in March, 1943, at which time the Inglewood plant converted to the production of P-51 fighters.

The War Department, in December, 1940 – one year prior to Pearl Harbor – named North American as the managing contractor for a new assembly plant to be built by the Government in Kansas City.

Fourteen months after this project was announced, the AAF accepted its first B-25 from the new plant. However, 28 months elapsed before the Kansas City plant reached its peak of production when 270 B-25's were produced in May, 1944. It required nearly four years to reach this peak from the date the project was announced!

The total elapsed time from the designing of the B-25 medium bomber to scheduled volume production, therefore, required a total of four years and eight months.

During this period, 156,000 engineering manhours were used to make the 8,000 drawings required for the first bomber. By the middle of 1945, a total of about 4,500,000 engineering hours had been expended on this bomber. In all, over 1,600 engineering changes were made in the B-25.

The B-25 bombers that were used up until 1944 carried no armor plate and the fuel tanks were of limited capacity and not of the self-sealing type. However, the combat record of the B-25 is one of the best. It did yeoman work on all fronts and was the "backbone of medium bombardment."

Thus, the development and production record of the B-25 re-emphasizes the fact that in a total of nearly four years of war, we failed to complete the cycle of design, engineering, producing and combat-testing a single airplane!

Actually the production time-table of the B-25 is exceptional when compared with the production records of many other World War II aircraft. The P-47 Thunderbolt and the B-29 Superfortress required nearly six years to come from the designing board to volume production.

The Air Materiel Command has been charged responsible for a workable, industrial mobilization plan for the Army Air Forces.

One of the fundamental pillars to peacetime pre-

* Paper "Plans for Industrial Air Preparedness," By General Gordon, Deputy Commanding General, Air Materiel Command for Plans (T-5), was presented at SAE National Aeronautic Meeting, Los Angeles, on Oct. 4, 1946.

paredness planning is an adequate research and development program carried through production. We expect our Air Forces' test laboratories, working with aircraft manufacturers, to provide a "preparedness plane" that is constantly abreast of advancements in aircraft. We expect to have a "preparedness plane" in each category of fighting craft – such as very heavy bomber, heavy bomber, medium bomber, fighter, pilotless aircraft and others.

Volume Production is Basic

We cannot repel an attack from the air with "blue print" or experimental aircraft! Volume production is fundamental to the maintenance of a superior combat air force!

A second pillar is the maintenance of an aircraft industry capable of rapid expansion. We believe it is necessary to maintain a production rate of approximately 3000 military aircraft or an aggregate of 30,000,000 lb of airframe weight per year. By doing this, we are accomplishing two important goals of industrial preparedness planning. First, this annual production figure, added to private and commercial aircraft requirements, should sustain the aircraft industry at a "healthy" level. By a "healthy" level, we mean a broad base from which the aircraft industry can expand rapidly when necessary.

A second goal that would be attained concerns the first element of national strength—armed-strength-in-being. A continuous supply of modern military aircraft to the Air Forces will maintain our country's first line of defense.

Establishment of a research and development program and the maintenance of an aircraft industry capable of rapid expansion is the consummation of two vital phases of peacetime industrial planning.

To go further, we must maintain an industrial reserve of production facilities and resources, which may be considered the third pillar.

As you know, the Government constructed a number of large air frame and engine plants throughout the country. These plants should be considered as recoverable facilities necessary to a security program for America. Present plans are to sell or lease these plants under special provision, including agreement that no major structural changes be made and that the Government may recapture the plant within 60 days at its discretion.

As part of an industrial reserve, the provision of tools for volume production of aircraft requires advance preparation. Total war demands a greater number of general purpose tools than would be available by conversion from the peacetime industry. New procurement of machine tools would overload the machine tool industry to the extent that the other services could not obtain their requirements. However, a reserve of tools acquired from existing government stocks would reduce substantially our estimated requirement during the first year of mobilization.

Possible wartime demands for critical and strategic materials must be provided for during peacetime, and the Army-Navy Munitions Board has developed a comprehensive scheme for the stockpiling of these materials.

A fourth pillar to industrial preparedness planning is the undertaking of detailed industrial preparedness measures, jointly between the services and industry to keep certain of our latest air weapons in a state of readiness for volume production.

By a state of readiness, we mean that specific models of airweapons – which we will say are "hot" – will receive detailed production planning to assure volume output in less than a year. We plan to procure pilot lines of high production tools for one "hot" fighter and one "hot" bomber and their related equipment, in order to attain very rapid volume production on these models.

On other aircraft, we plan to purchase detailed production engineering, drawings, plant layouts, bills of material, and tool designing to the extent that many months will be saved in reaching volume production.

Our plans will be projected during peacetime to arrange for potential subcontractors to build parts for the prime contractors. Prospective licensee companies will also participate in the program.

This brings me to my final point. Assuming the outbreak of an emergency, it is apparent that the first wave of enemy aircraft must be met, both offensively and defensively, by the combat planes in the hands of our tactical air units throughout the world. In the first phase, replacements and additions in the desired quantities can come only from the air weapons actually then in production. It seems probable that the final period will be fought, and, we trust, won, with air weapons, if not developed, at least on the drawing boards at the beginning of the emergency.

This, then, is the all-important Air Industrial Plan. Actually, it is the by-product of cooperation and coordination between industry and the military. It was this cooperation and coordination that gave us victory over the Axis. It is this same cooperation and coordination during peacetime that will guarantee security for America in the future.

ERRATUM

On p. 54 of the December, 1946, Journal, in the article entitled "For Car Windows – Plastic or Glass?", from a paper by G. B. Watkins and J. D. Ryan, the illustrations for Figs. 1 and 3 were transposed. The photograph in Fig. 1, described by the caption as a Plexiglas half windshield, is the glass half windshield referred to in the caption for Fig. 3; and the Plexiglas windshield in Fig. 3 should be Fig. 1.

MACH-REYNOLDS RELATION PROBED

FROM A PAPER BY **John R. Spreiter and Paul J. Steffen***

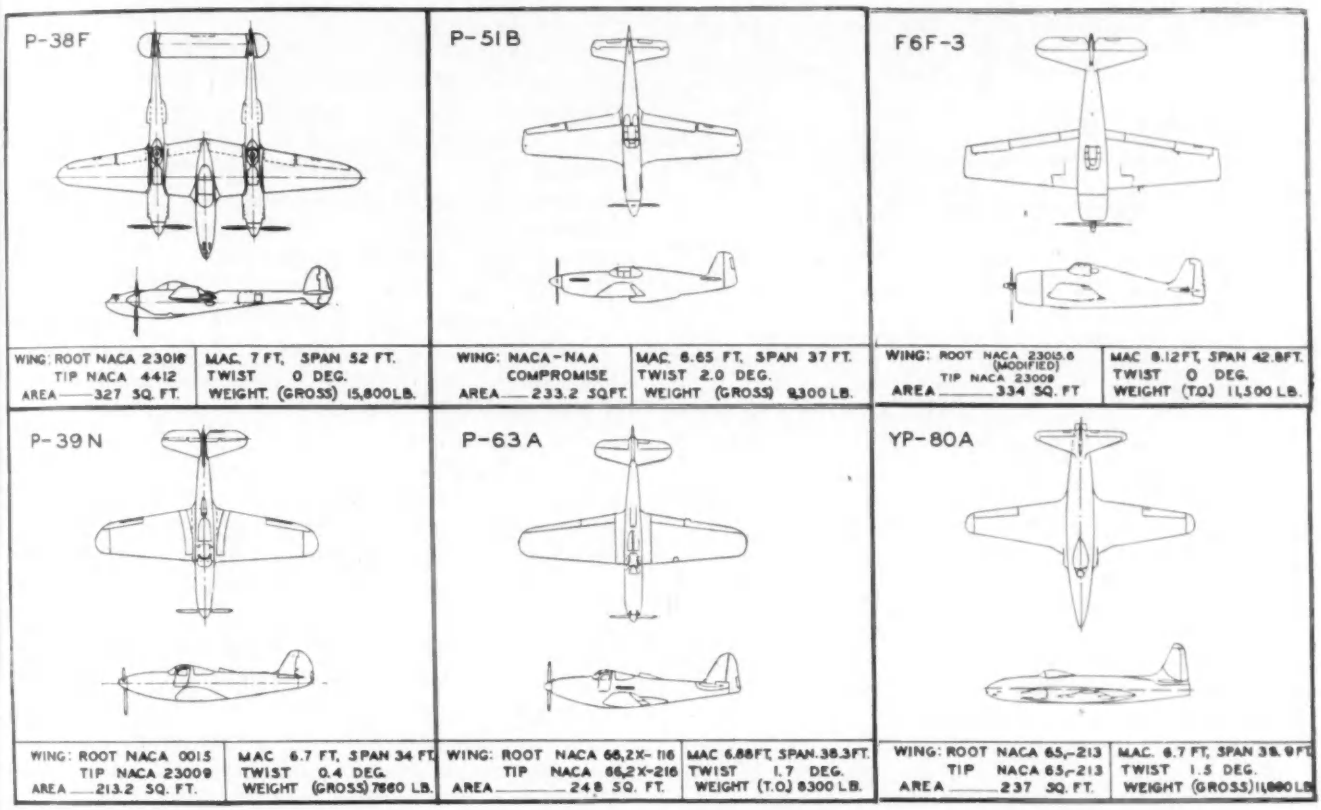

P-38F
WING: ROOT NACA 23018 TIP NACA 4412 AREA 327 SQ. FT.
MAC. 7 FT, SPAN 52 FT. TWIST 0 DEG. WEIGHT (GROSS) 15,800 LB.
P-51B
WING: NACA-NAA COMPROMISE AREA 233.2 SQ.FT.
MAC. 6.65 FT, SPAN 37 FT. TWIST 2.0 DEG. WEIGHT (GROSS) 9,300 LB.
F6F-3
WING: ROOT NACA 23015.6 (MODIFIED) TIP NACA 23009 AREA 334 SQ. FT.
MAC 8.12 FT, SPAN 42.8 FT. TWIST 0 DEG. WEIGHT (T.O.) 11,500 LB.
P-39N
WING: ROOT NACA 0015 TIP NACA 23009 AREA 213.2 SQ. FT.
MAC 6.7 FT, SPAN 34 FT. TWIST 0.4 DEG. WEIGHT (GROSS) 7860 LB.
P-63A
WING: ROOT NACA 66,2X-116 TIP NACA 66,2X-216 AREA 248 SQ. FT.
MAC 6.88 FT, SPAN 38.3 FT. TWIST 1.7 DEG. WEIGHT (T.O.) 8300 LB.
YP-80A
WING: ROOT NACA 65,-213 TIP NACA 65,-213 AREA 237 SQ. FT.
MAC. 6.7 FT, SPAN 38.9 FT. TWIST 1.5 DEG. WEIGHT (GROSS) 11,000 LB.

Fig. 1 – Airplanes tested in flight

KNOWLEDGE of the effects of Mach and Reynolds numbers on maximum lift coefficient has become essential to further gains in aircraft speeds and altitudes.

Early tests, conducted either at full-scale Reynolds numbers and low Mach numbers or at small Reynolds numbers and high Mach numbers, demonstrated the need for data on the combination of full-scale Reynolds and high Mach numbers.

This information has now become available from flight tests covering ranges of Mach numbers from 0.15 to 0.72 and of Reynolds numbers from 4,400,000 to 19,500,000.

Analysis of the test results suggests such conclusions as:

1. Critical Reynolds number increases almost linearly with Mach number.
2. Differences in the maximum lift coefficient for the laminar and the turbulent regimes become progressively smaller as Mach number increases.
3. Maximum lift coefficient is not affected by Mach numbers below about 0.15.
4. Distinct differences exist between the effects of both Mach and Reynolds number on the maximum lift coefficient in the subcritical and supercritical Mach number regions.
5. In the subcritical Mach number region, the maximum lift coefficient decreases steadily with increasing Mach number.
6. As the supercritical Mach number region is

*"An NACA Flight and Wind-Tunnel Investigation of Maximum Lift as Affected by Variations of Mach and Reynolds Numbers," by John R. Spreiter, aeronautical engineer, and Paul J. Steffen, mechanical engineer, Ames Aeronautical Laboratory, NACA, was presented at the SAE National Aeronautic Meeting, New York City, April 5, 1946.

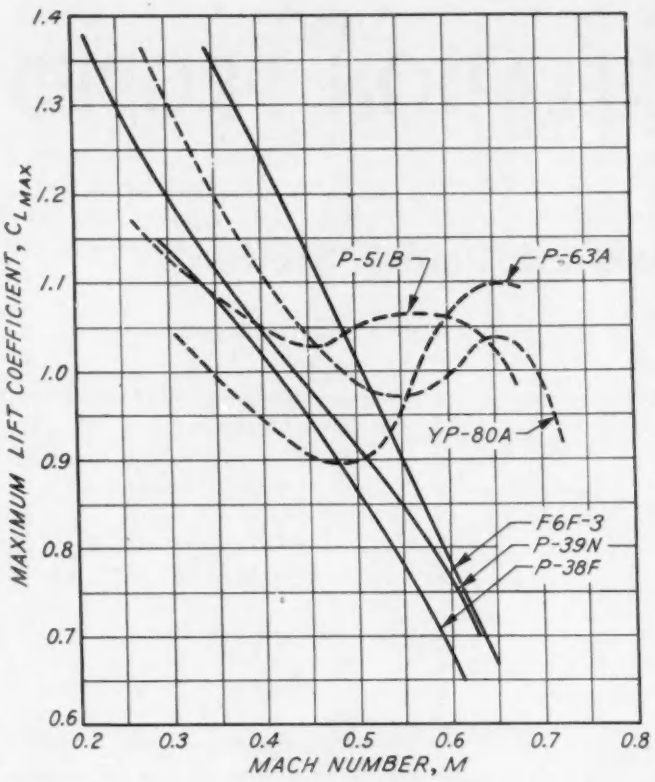


Fig. 2 – Variation of maximum lift coefficient with Mach number at high altitude (average altitude: 25,100 ft for F6F-3; 28,000 ft for P-38F; 23,300 and 25,700 ft for P-39N; 29,300 ft for P-51B; 32,300 ft for P-63A; 20,100 and 29,800 ft for YP-80A)

——— Conventional airfoils used

— — — — Low-drag airfoils used

entered, the maximum lift coefficient of conventional airfols continues to diminish, while that of the low-drag airfoils reaches a minimum at 0.40-0.55 Mach number, and then begins to increase until a secondary peak value is reached at about 0.60-0.66.

7. In the subcritical Mach number regions, Reynolds number has a decreasing influence on the maximum lift coefficient as Mach number increases. This influence becomes nil at about 0.55 Mach number.

8. At supercritical Mach numbers, no effects of Reynolds number were apparent on two of the three airplanes tested.

9. When the effects of both Mach and Reynolds number are considered, good correlation exists between flight and wind-tunnel data, provided buffeting or other factors do not prevent the attainment of the actual maximum lift coefficient. The same considerations provided good agreement among limited airfoil data from various wind tunnels.

Airplanes Used

The airplanes used in the test were: Lockheed P-38F, Bell P-39N, and Grumman F6F-3, which were equipped with NACA conventional airfoils; Bell P-63A and Lockheed YP-80A, which were provided with NACA low-drag airfoils; and P-51B, which was equipped with a North American Aviation-NACA compromise low-drag airfoil. (See Fig. 1.)

The P-51B and YP-80A had carefully filled, waxed, and polished surfaces. The other planes were painted with standard camouflage paint. Of all the planes tested, the P-38F and P-39N had the roughest finish and the most openings in the wings.

Tests were also made with 0.167-, 0.350-, and 0.333-scale models of the P-38, P-39N, and XP-80 airplanes, respectively in the Ames 16-ft high-speed wind tunnel. The XP-model was complete, the P-38 model was complete except for propellers, and the P-39N model was complete except for propeller and tail.

Airfoils tests were run in the Ames 1- by 3½-ft high-speed tunnel with 6-in.-chord metal models mounted so as to span completely the width of the tunnel test section.

Other airfoil tests were conducted in the Langley 2-dimensional wind tunnel with 2-ft-chord wooden models mounted so as to span completely the width of the 3- by 7½-ft rectangular test section.

Test Procedure

Gradual stalls were made during turns or pullups with the airplanes in the clean position (flaps and landing gear up). All stalls with the five propeller-driven planes were made with the engine throttled and the propeller in the high-pitch setting. Although the power was on during the stalls of the jet propelled YP-80, the data were considered similar to the power-off condition of the propeller-driven planes as no slipstream existed over the wing.

Data recorded included: indicated air speed, pressure altitude, normal acceleration, pitching and rolling velocities, and free-air temperatures.

The airplane characteristics that were assumed to indicate graduals stalls are summarized in Table 1.

Table 1 – Characteristics of Airplanes Assumed to Indicate Gradual Stalls

Airplane	At Low Mach Numbers	At High Mach Numbers
F6F-3	Roll-off and slight buffeting	Moderate buffeting with pitch-down, followed by porpoising motions
P-38F	Slight buffeting	Buffeting (Pilot reported apparent ineffectiveness of elevators to increase lift coefficient)
P-39N	Buffeting and roll-off	Buffeting and pitch-down
P-51B	Buffeting and roll-off	Severe buffeting with mild roll-off
P-63A	Roll-off and pitch-down	Abrupt roll-off
YP-80A	Roll-off with slight buffeting	Slight buffeting

At low Mach numbers it is shown that the stalls of all the airplanes but the P-38F were characterized by roll-off. Such stalls are clearly defined by the motions of the airplane, so that the maximum lift coefficients obtainable in flight are relatively independent of piloting technique and the amount of control available, and would probably be similar to the values measured in a wind tunnel. At high Mach numbers, however, the stalls of only two

airplanes were characterized by roll-off, those of the remaining airplanes being characterized by buffeting accompanied, in some cases, by pitching motions. Maximum lift coefficients defined by buffeting are probably less than the actual maximum lift coefficient by amounts that are a function of what the pilot considers tolerable buffeting limits. It should be noted that the maximum-lift-coefficient data were repeatable even when determined by buffeting considerations, indicating that the flight values have significance as the maximum usable lift coefficient of the airplane.

A full report of the tests has been published by the NACA.[1]

Effect of Mach Number

Fig. 2 makes it clear that the maximum lift coefficients of the airplanes with conventional airfoils (P-38F, P-39N, and F6F-3) diminish continuously from the lowest to the highest Mach numbers; whereas those for the airplanes with low-drag airfoils (P-51B, YP-80A, and P-63A) decrease continuously until they reach minimums at a Mach number of 0.40-0.55 and then begin increasing until peak values are reached at 0.60-0.66 Mach number. (The theoretically computed critical Mach number of the airfoils tested was approximately 0.4.)

The decrease in maximum lift coefficient with increasing Mach number in the subcritical Mach number range may be attributed to the separation of the boundary layer at smaller angles of attack induced by the compressibility-steepened adverse pressure gradient.

The reasons for the diverse characteristics exhibited by low-drag and conventional airfoils at supercritical Mach numbers are illustrated by the pressure distributions of Fig. 3. For instance, the higher maximum lift coefficients obtained as Mach number is increased for the low-drag airfoil are shown to be due to a broadening of the upper-surface low-pressure region that more than offsets the reduction in pressure peak at the nose of the airfoil. This effect persists up to a Mach number of 0.60-0.66. At this point the *loss* in lift due to the decrease in pressure peak finally offsets the *addition* of lift due to broadening of the low-pressure region. With the conventional airfoil, the maximum lift coefficient continues to decrease up to the highest Mach number of the tests because the negative pressure peak does not broaden enough to counteract the loss in lift produced by the lowering of the pressure peak. The curves also show that nearly all the observed changes in maximum lift coefficient are caused by upper-surface effects, since the lower-surface pressure distributions on both airfoils remain virtually unchanged.

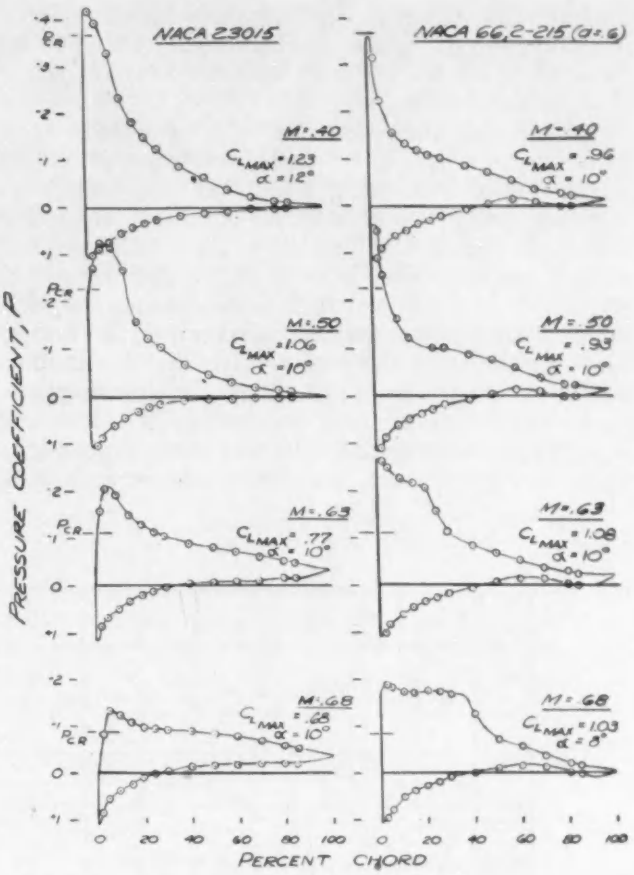


Fig. 3 – Typical pressure distributions on NACA conventional airfoil (left) and low-drag airfoil (right) at maximum lift coefficient

Effect of Reynolds Number

The variation of maximum lift coefficient with Reynolds number for constant Mach number is shown in Fig. 4. It can be seen that at the lower Mach numbers, the maximum lift coefficients of the P-51B and P-63A remain nearly constant until the critical Reynolds number is reached, then it increases rapidly until, at a high value it becomes nearly constant again. A similar trend is indicated for the P-39N, although the tests were not extended to low enough Reynolds numbers to define the critical.

These effects are qualitatively consistent with those described by Jacobs and Sherman.[2] The constant value of maximum lift coefficient at low Reynolds numbers is caused by laminar separation of the boundary layer; the increasing values of maximum lift coefficient beyond a critical Reynolds number occur as the boundary-layer separation changes from laminar to turbulent; and the nearly constant value of the maximum lift coefficient at the higher Reynolds numbers is produced by tur-

[1] See NACA Technical Note No. 1044 (1946), "Effect of Mach and Reynolds Numbers on Maximum Lift Coefficient," by J. R. Spreiter and P. J. Steffen.

[2] See NACA Technical Report No. 586 (1937), "Airfoil Section Characteristics as Affected by Variations of Reynolds Number," by E. N. Jacobs and A. Sherman.

bulent separation of the boundary layer. Quantitatively, the Reynolds number effects found in the present tests were much smaller than those of Jacobs and Sherman.[2]

Fig. 4 also indicates that the increment from laminar separation to turbulent separation decreases with increasing Mach number, finally becoming zero at 0.50-0.60 Mach number. The maximum lift coefficient corresponding to turbulent separation decreases at a much greater rate than the coefficient corresponding to laminar separation. This characteristic probably may be attributed partially to the higher local Mach numbers involved at the larger lift coefficient of the maximum lift coefficient corresponding to turbulent separation, causing the adverse pressure gradients to be steepened more than those corresponding to the maximum lift coefficient for laminar separation. Another contributing factor may be that the turbulent separation, originating at the trailing edge, is affected by the compressibility-steepened adverse pressure gradient along the entire chord, while the laminar separation, occurring near the leading edge, would be influenced mainly by the steepened pressure gradients over only a smaller portion of the chord.

Interrelated Effects

While the effects of Mach and Reynolds numbers on the maximum lift coefficient have been discussed as though they were entirely separate and independent phenomena, the actual effects of each variable are modified to a secondary extent by the value of the other. (See Fig. 5.) In general, the

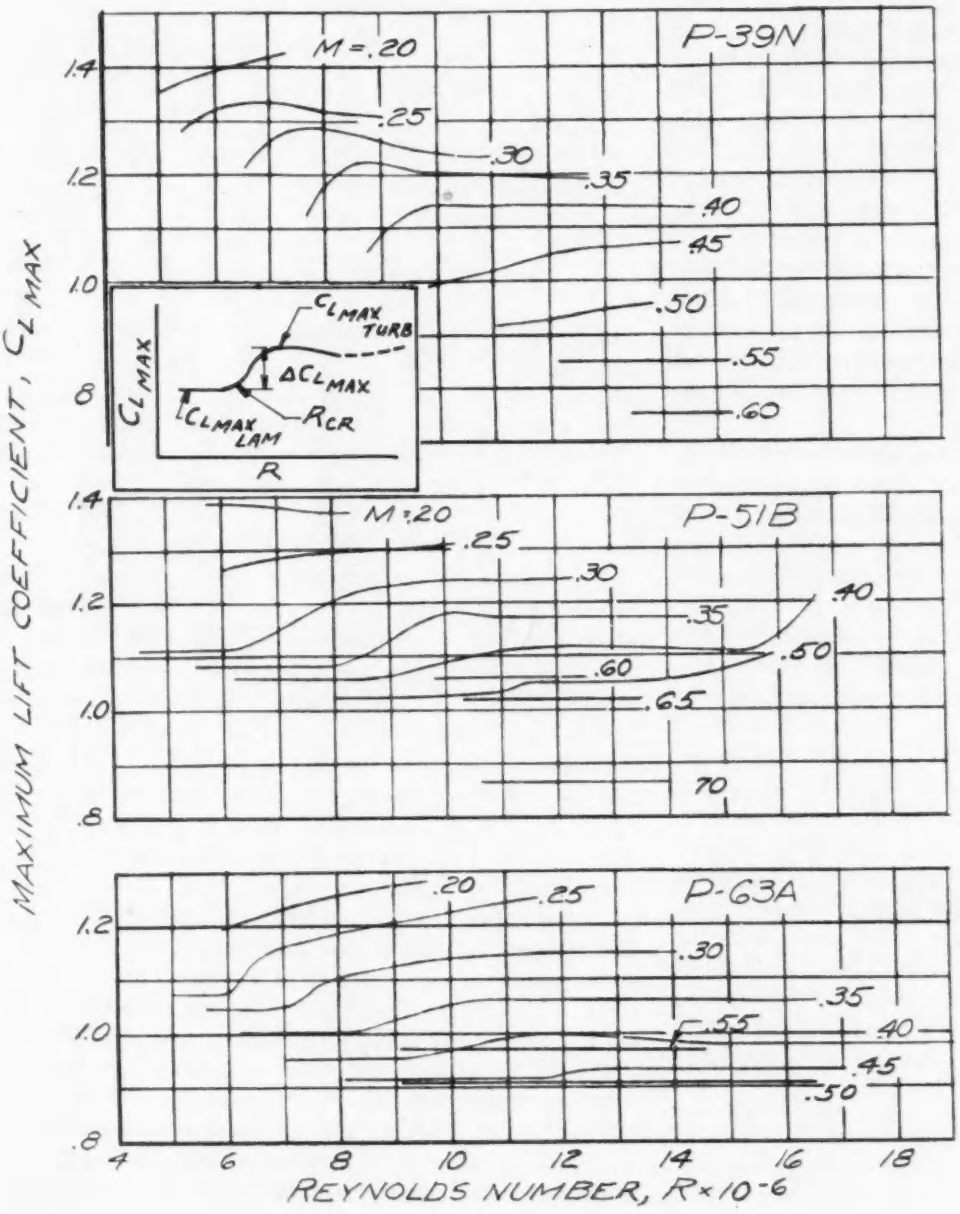


Fig. 4 – Variation of maximum lift coefficient with Reynolds number for constant Mach number

Insert shows relation of coefficient of maximum lift corresponding to laminar separation, coefficient of maximum lift corresponding to turbulent separation, increment from laminar to turbulent separation, and critical Reynolds number

interaction of Mach and Reynolds number effects is such that the variation of the maximum lift coefficient with either variable remains qualitatively as already described, although modified quantitatively.

Subcritical Mach Number Range – Fig. 4 shows that, as Mach number increases for the P-51B and P-63A, the critical Reynolds number becomes greater while the characteristic effects of Reynolds number become smaller, finally disappearing at moderately supercritical Mach numbers. The same general trends may be seen in the data for the P-39N, although the test range does not extend to Reynolds numbers as small as the critical.

In fact, the critical Reynolds number of the P-51B and P-63A vary almost linearly with Mach number throughout the range tested. Such variation could be caused by two effects. One is the increase of kinematic viscosity in the boundary layer of a compressible fluid due to aerodynamic heating, which causes the ratio of local Reynolds number (based on boundary-layer conditions) to the free-stream Reynolds number to diminish. Accordingly, a larger free-stream Reynolds number would be necessary to reach the local critical Reynolds number required for transition from laminar to turbulent boundary layer. A second possibility depends on the fact that increasing the Mach number in the subcritical range has effects on the upper-surface pressure distributions similar to those of decreasing the airfoil thickness. Decreasing the airfoil thickness is shown by Jacobs and Sherman[2] to increase the critical Reynolds number, hence similiar effects due to increasing Mach number would be anticipated.

Supercritical Mach Number Range – At supercritical Mach numbers, Fig. 4 shows that the maximum lift coefficient continues to vary rapidly with changes in Mach number and that the usual Reynolds number effect, as described previously, becomes negligibly small at a Mach number of 0.55 for all airplanes tested.

Comparison of Data

To determine if the general effects of Mach and Reynolds numbers indicated by the flight data are adequate to permit correlation of flight and wind-tunnel results, tunnel data, although obtained at combinations of Mach and Reynolds numbers not

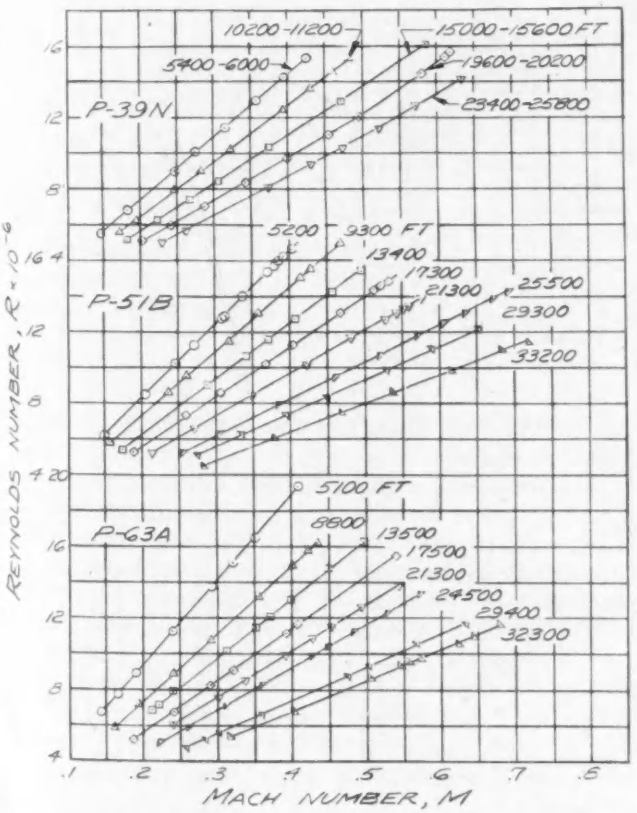


Fig. 5 – (Above) Variation of Reynolds number with Mach number

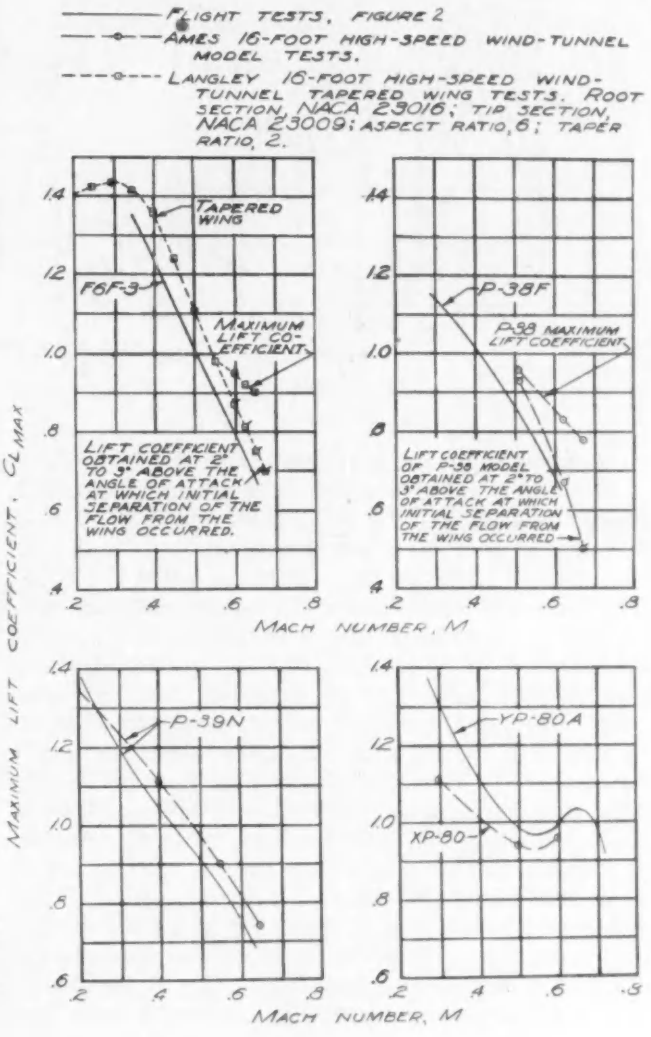

FLIGHT TESTS, FIGURE 2
AMES 16-FOOT HIGH-SPEED WIND-TUNNEL MODEL TESTS.
LANGLEY 16-FOOT HIGH-SPEED WIND-TUNNEL TAPERED WING TESTS. ROOT SECTION, NACA 23016; TIP SECTION, NACA 23009; ASPECT RATIO, 6; TAPER RATIO, 2.
TAPERED WING
F6F-3
MAXIMUM LIFT COEFFICIENT
LIFT COEFFICIENT OBTAINED AT 2° TO 3° ABOVE THE ANGLE OF ATTACK AT WHICH INITIAL SEPARATION OF THE FLOW FROM THE WING OCCURRED.
P-38F
P-38 MAXIMUM LIFT COEFFICIENT
LIFT COEFFICIENT OF P-38 MODEL OBTAINED AT 2° TO 3° ABOVE THE ANGLE OF ATTACK AT WHICH INITIAL SEPARATION OF THE FLOW FROM THE WING OCCURRED
MACH NUMBER, M
P-39N
YP-80A
XP-80
MAXIMUM LIFT COEFFICIENT, CLMAX
MACH NUMBER, M

Fig. 6 – (Right) Comparison of high-altitude flight data with wind-tunnel data showing variation of maximum lift coefficient with Mach number

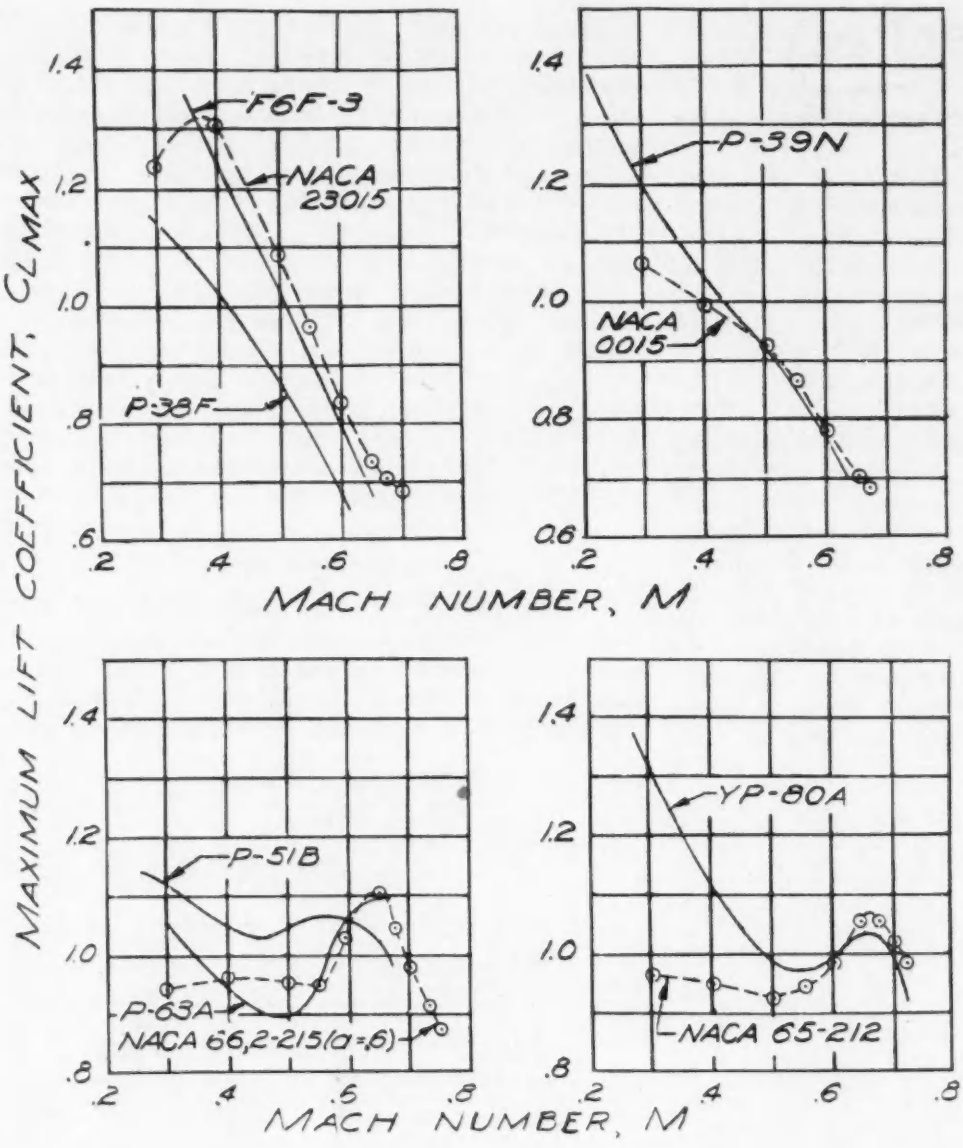


Fig. 7 – Comparison of high-altitude flight data with wind-tunnel data showing variation of maximum lift coefficient with Mach number

——— Flight tests, Fig. 2
— — — — Ames 1- by 3½-ft high-speed wind-tunnel model tests

covered in flight, are compared with the flight data.

Maximum-lift-coefficient data obtained on models of the P-38, P-39N, and XP-80 in the 16-ft wind tunnel and corrected for trim are presented in Fig. 6, together with the high-altitude data of Fig. 2. The Reynolds numbers for the tunnel tests are considerably lower than those of the flight tests. A comparison of the maximum lift coefficients obtained from flight and wind-tunnel data indicates that, although the same qualitative effects of Mach number are shown in all the data, absolute agreement between the actual values of the coefficients measured in flight and in the tunnel does not always exist. Most of the discrepancies, however, may be accounted for by a consideration of all the pertinent variables. In general, considering only the difference between the Reynolds numbers of the flight and tunnel tests, the comparison should show close agreement existing at the higher Mach numbers but lower maximum lift coefficients for the tunnel data than for the flight data at lower Mach numbers.

Maximum lift coefficient data obtained in the 1- by 3½-ft wind tunnel for 2-dimensional models of NACA 23015, 00.15, 66,2-215, and 65_1-212 airfoils that are approximately similar, respectively, to the root sections of the P-38F and F6F-3, P-39N, P-51B and P-63A, and YP-80A are presented in Fig. 7, together with high-altitude flight data of Fig. 2.

For the airfoils and Mach number ranges of Fig. 7, no appreciable difference existed between initial stall lift coefficient and maximum lift coefficient.

Because of the differences between a 2-dimensional airfoil model in a tunnel and an airplane in flight, only qualitative verification of the trends indicated by the flight data should be anticipated and any close quantitative agreement is probably merely coincidental.

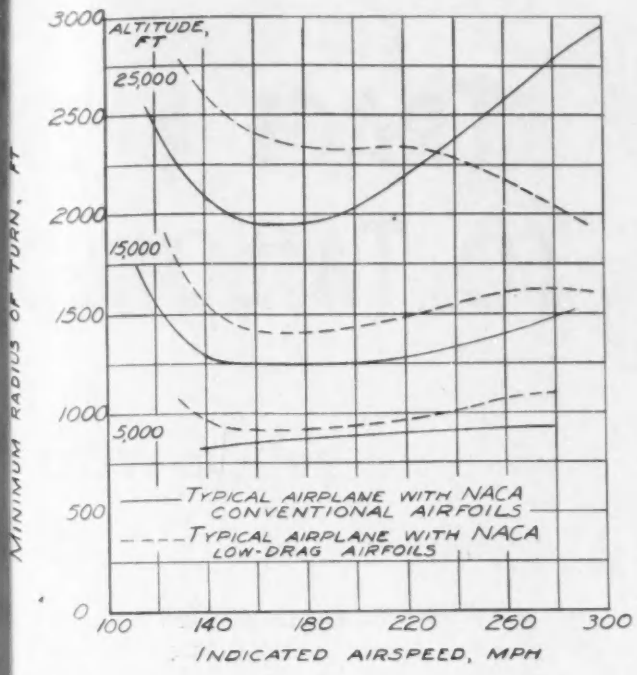


Fig. 8 – Calculated minimum radii of turn of typical airplanes with NACA conventional and low-drag airfoils (wing loading: 34 psf)

The maximum lift coefficient corresponding to laminar separation is a sensitive function of camber, but relatively independent of thickness, while the critical Reynolds number varies greatly with thickness but only slightly with camber. Both camber and thickness affect the maximum lift coefficient corresponding to turbulent separation, but to a lesser extent than they do maximum lift coefficient corresponding to laminar separation of critical Reynolds number.

Maximum lift coefficient did not vary as much with Reynolds number for the flight tests as for the tunnel tests because the former tests were run at higher Mach numbers than the latter. Actually, if the maximum lift coefficient data for the flight tests are extraplated to very low Mach numbers, the apparent discrepancies between the two types of tests disappear.

Similarly, differences in critical Reynolds number for flight and tunnel tests are accounted for by the lower Mach numbers at which the tunnel tests were made. Flight data show that critical Reynolds number is a direct function of Mach number.

Applications

To show the magnitude of the effects on an entire airplane resulting from variations of maximum lift coefficient with Mach and Reynolds numbers, two typical applications of maximum-lift data are presented, one representing the influence of maneuvering characteristics, the other, the effect on the loads imposed on the structure during maneuvers.

A practical consequence of the difference in the maximum-lift characteristics of conventional and low-drag airoils is illustrated in Fig. 8. This figure shows the variation with indicated air speed of the computed minimum radius of properly banked, power-off, horizontal turns of two airplanes differing only in airfoil sections.

It is immediately apparent from Fig. 8 that for low air speeds conventional airfoils produce smaller turning radii. For higher speeds at high altitude where the critical speeds of the airfoil sections are low at high lift, the low-drag airfoils are superior. It appears that this same effect probably occurs at lower altitudes for higher speeds than those shown in Fig. 8.

The effects of variations of maximum lift coefficient with Mach and Reynolds numbers on the loads imposed on the plane structure during maneuvering flight are illustrated in Fig. 9 by speed-load diagrams showing variation with indicated air speed of the maximum acceleration factors attainable in gradual stalls. For purposes of comparison, the corresponding portions of the diagrams are computed by the usual design method of assuming that the normal acceleration factor equals the square of the ratio of airplane speed to the stalling speed in straight flight are also shown.

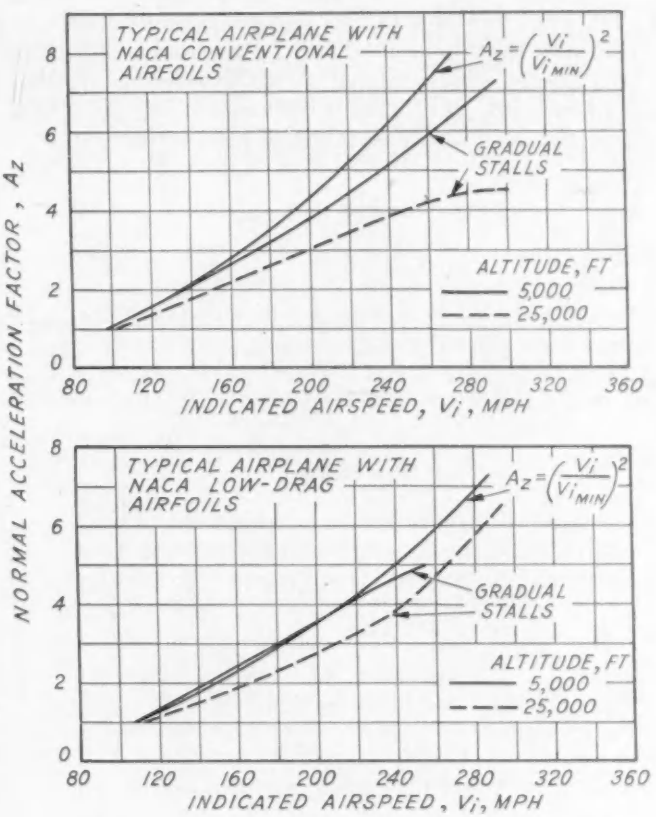


Fig. 9 – Speed-load diagrams for typical airplanes with NACA conventional and low-drag airfoils (wing loading: 34 psf)

TRACE B-29 TO TAILORED

Excerpts from paper **By E. C. WELLS***

B-29 growing pains set an example for design of future military aircraft, says Wells Only by embodying operating conditions in its design was it possible to exploit fully this airplane's potentialities.

In this article he cites several cases where weight and drag considerations boomeranged because operating conditions were neglected.

Cognizance of this relationship led to changes that boosted the B-29's bomb load from 5000 to 20,000 lb and at the same time increased its range.

VITAL to the success of any long-range combat aircraft is the integration of operating procedures with weight and drag effects. Developing these procedures to match the airplane and the conditions under which it must operate largely is responsible for progressive performance improvements of the B-29.

Interrelation of the weight factor, operating conditions, and operating procedures is forcefully illustrated by the effects of certain design changes made midway in the B-29 program.

For example, it was estimated that available facilities would be able to produce B-29 airplanes in greater quantities if the center wing section panel, originally designed as one structural assembly, could be redesigned to provide a production assembly joint at each side of the fuselage. The first layouts of this change showed that a weight penalty of 1000 to 1500 lb would be required, since these joints came in the most highly stressed section of the wing structure.

By more careful redesign, it was possible to reduce this penalty to less than 700 lb. It was then decided that the change should be made, airplanes so modified to be known as B-29A airplanes. This decision was based in part on the assumption that the effect on combat operations could be measured in terms of a 700-lb increase in weight empty with a corresponding increase in fuel load and gross weight.

Because of the close interrelation between weight and operating procedures and operating conditions, this assumption proved for a time to be erroneous to a degree which was very costly in terms of bomb load carried by B-29A airplanes. The interrelation between these factors developed as follows:

1. B-29 and B-29A airplanes were designed to carry a load of bombs or interchangeably one or two bomb bay fuel tanks in each of the two bomb bays;

2. At the time the first B-29A airplanes went into combat, B-29 airplanes were operating with two bomb bay tanks in one bay and a full load of bombs in the other bay.

3. The weight empty of the B-29A was approximately 700 lb greater than the B-29. But because of the space taken up by the added wing joints, the built-in fuel capacity of the B-29A was of necessity 210 gal less than the B-29.

4. To handle the added weight empty and to make up for the loss in built-in fuel space, it was necessary for the B-29A to carry a third bomb bay tank to have the range at that time being flown by the B-29.

5. Since one tank utilized one-half the space in each bomb bay, the bomb load capacity of the B-29A under the particular operating procedures, operating conditions, and weight limitations existing at that time was only half that of the B-29.

In time, operating procedures and operating conditions were modified and improved, and the interrelation of these factors served to eliminate this penalty. The example clearly illustrates, however, that the validity of important assumptions may have a profound effect upon the ultimate results of design decisions.

Another striking example had made itself painfully evident earlier in the war. One of the most heroic efforts made in this war was that credited to the officers and men under the command of Major-Gen. K. B. Wolfe who prepared the first B-29's for combat and who flew those airplanes two-thirds of the way around the world finally to strike the first major aerial blow at Japan. Flying heavily loaded bombers from the bases in

POTENCY DESIGN

China over long stretches of mountainous and enemy territory took everything the crews could get out of their aircraft. But looking back on that effort it is apparent that even a design change intended to give the combat crew a break can sometimes have the opposite effect.

In preparing the B-29's for combat, the upper forward gun turret was changed from a 2-gun turret to a 4-gun turret. This change was made in an effort to provide more fire power in the forward direction; but such added fire power was obtained only at the expense of some 880 lb of weight, a substantial increase in drag, and a detrimental crowding of the crew in the forward pressurized compartment.

Operational Parasites Multiplied

This increase in weight and drag was made even more critical by the extremely adverse conditions under which the airplanes were forced to operate. The resultant reduction in bomb load became 1800 lb rather than 880 lb, the change in weight empty. The 1800-lb loss consisted of these three factors:

a. 880-lb direct loss in bomb load due to increased weight empty;

b. 260-lb bomb load that had to be converted to fuel to carry 880 lb of gun turret on return trip, and

c. 660-lb bomb load that had to be converted to fuel to counteract increased drag of 4-gun turret.

The examples cited serve to show how critical weight and drag changes can be when they relate to operating conditions. Operating procedures in themselves can be equally critical, as has been so clearly demonstrated by the wartime experiences with the B-29 series airplanes.

Bombloads Found Varying

Making due allowances for the adverse effect of weight and drag increases, it became apparent after the first operations from China and the Marianas that the B-29 was not carrying the bomb load that should be carried on each trip. Some airplanes and crews consistently did quite well, returning with large reserves of fuel, while others were forced to ditch their airplanes on the return trip.

In the first few months of operation from the Marianas, the reserve fuel measured in airplanes returning to base varied from less than 200 gal to more than 1400 gal for airplanes with identical loads and equipment. Such wide variations could be traced in part to carburetor metering variations, poorly calibrated on faulty cylinder-head temperature gages, and other differences between various aircraft and engines.

In addition to these factors, the magnitude of the variation in reserve fuel indicated that variations in operating procedures and in the skill with which those procedures were being used were hav-

* Paper "The History and Development of the B-29," by E. C. Wells, Chief Engineer of Boeing Aircraft Co., was presented at the SAE National Aeronautic Meeting, Oct. 4, 1946.

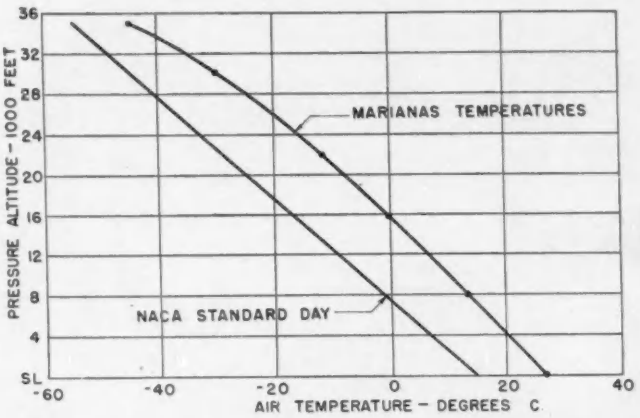


Fig. 1 – Survey of weather conditions in the B-29 operating area showed temperatures at all altitudes to be higher than standard

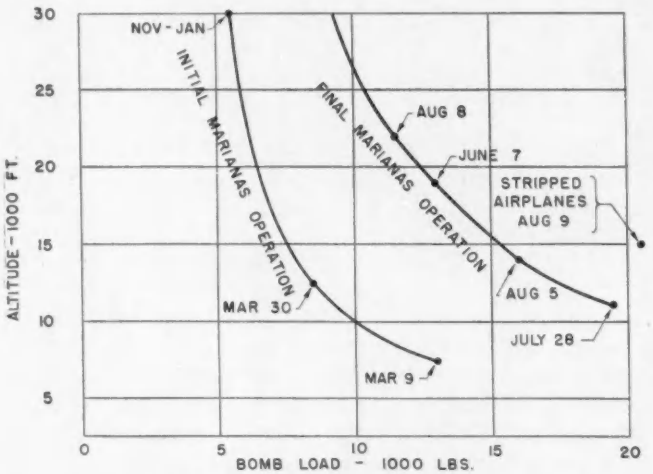


Fig. 2 – By continually improving operating procedures, engineers nearly quadrupled the B-29's bomb-carrying capacity

ing a pronounced effect on the results being obtained. It also indicated that if the best operating procedures were used by all crews, the average bomb load could be materially increased.

A gradual increase did occur as crews became better trained, and as the command brought about the mandatory use of the best known operating procedures. Even the best crews, however, fell short of the estimated capabilities of the airplane. It appeared to be in order to concentrate on finding the reasons behind the difference between actual and predicted performance.

As a first step in this program, the command initiated several drastic changes in tactics to eliminate factors which appeared to be critical in their effect on performance, and to obtain maximum effectiveness from the loads then being carried. The principal changes were as follows:

1. Missions were flown at lower altitudes;
2. Missions were flown at night;
3. Rendezvous and formation flying were eliminated;
4. Defensive armament was reduced to a minimum.

Each of these principal changes benefited the operation from the standpoint of load-carrying ability. In addition it was found that reductions in altitude and weight resulted in a marked improvement in engine life and reliability.

Coincident with this first step, it was also decided that some of the engineers who had been engaged in design, performance analysis, and flight test in the States, should get some firsthand knowledge of operating conditions in the Pacific. If possible, such knowledge should be converted into practical operating procedures which would bring out the best possible results in the theater of operations. Accordingly, a standard combat airplane was equipped with extra flight test instrumentation and was taken to the Pacific theater for a series of flight test operations.

These tests brought out many of the reasons for differences between actual and predicted performance, and provided practical operating procedures whereby these differences could be reduced to a minimum. The previously mentioned changes made in tactics effected a substantial reduction in these differences, but a further reduction was demonstrated to be feasible as a result of these on-the-spot flight tests.

The theater flight test program resulted in useful data relating to the following principal operational problems:

1. Effect of altitude on range;
2. Effect of humidity on power and fuel consumption.

Data were also obtained on other items such as effect of c.g. position on airplane drag, effect of parasite drag items on drag and range, operating procedures for 3- and 2-engine operation, and the value of jettisoning equipment in an emergency. The data obtained on these miscellaneous items were generally what might have been predicted by rational analysis. Data obtained on the principal problems relating to altitude and humidity finally proved to be very well in line with theory. But this proved to be the case only after the actual operating conditions were fairly accurately established by test observation.

In comparing initial operations at high altitude with later operations at medium altitude, it was apparent that the penalty of altitude operation was more severe than should have been anticipated under normal operating conditions. On one of the first test flights, observations were made of outside air temperature. The results are plotted in Fig. 1 in comparison with standard temperatures. It will be seen that temperatures at altitude are very high compared with standard.

It was found that although operation at medium altitude was much less costly than operation at high altitude, a further decrease of operating altitude –

concluded on page 55

Forecast: Fruitful Future for Jet

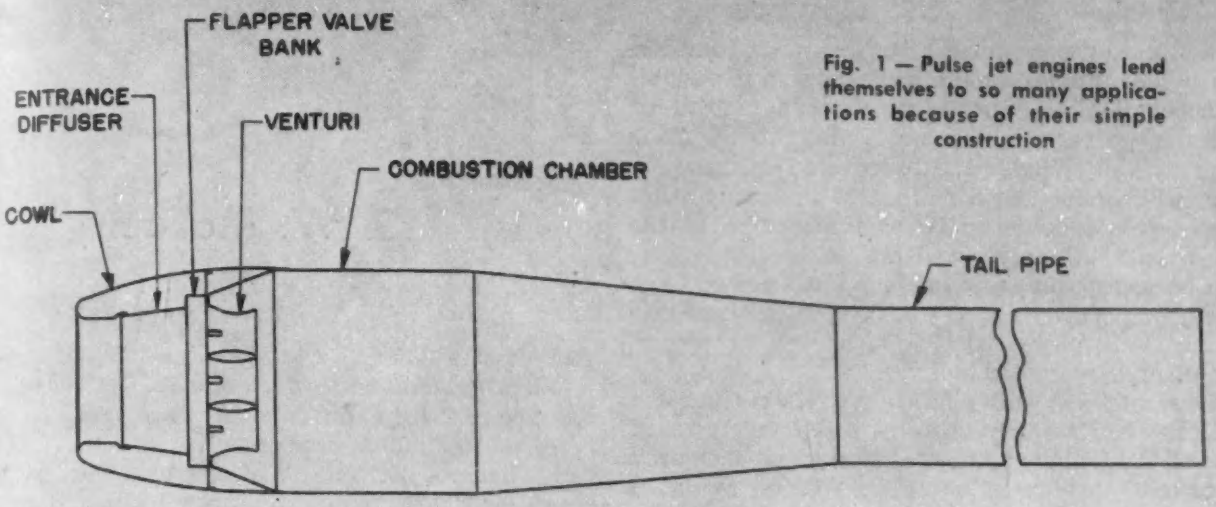


Fig. 1 — Pulse jet engines lend themselves to so many applications because of their simple construction

BASED ON A PAPER BY **L. B. Edelman***

FROM a harbinger of death as the German V-1 bomb engine to a propulsive unit for peacetime aircraft is the quick change in roles being made by the pulsating jet engine.

Covered in this paper, later to be presented in full in SAE Quarterly Transactions, is the progress made to date in pulse jet design and the engineering challenge that must be met if today's possibilities are to become tomorrow's realities.

Helicopter engineers are just one of several groups on the pulse jet bandwagon. They report that studies of jets at blade tips have been encouraging. Especially interesting for this purpose is the pulse jet. It has a wide range of speeds—including static conditions—and does away with the need for a mechanical compressor at the hub.

In fact several contemplated mechanical designs show more promise for pulse jets in helicopters than in conventional aircraft. One plan proposed is to place at the blade tips multiple short units fed by air scooped in either at the tip leading edge or at the hub and carried through hollow blades to the tips.

There are several advantages of the pulse jet over the reciprocating engine in helicopters. By eliminating the heavy engine and its gearing to the blades, great savings in weight, space, maintenance, and initial cost can be realized. Absence of a large torque transfer would reduce structural weight and relieve tail rotor problems. While fuel consumption would be higher on the basis of power delivered, power required for the same performance in speed, climb and payload would be reduced.

Pulsating jets are unusually well-suited to pilotless aircraft . . . for transport of mail, flight research, and military uses.

Even in conventional aircraft, the pulse jet can render valuable service in many ways. What a mental bracer it can be in a single-engine airplane in which engine failure is a serious situation!

In this case it can be installed in the fuselage for quick starting in an emergency. With a small pulse jet, thrust enough for speeds 15 mph above stall speed could be delivered for considerable periods.

Once effective muffling is achieved, applications will broaden to include power boosts for take-off from short or muddy fields or for overload conditions. It's even possible that thrust might be reversed to reduce speed for landing on small fields.

Pulse jet use is not limited to aircraft propulsion only. The Swiss have developed a blowerless heating unit operating on pulsating jet principles.

What makes the pulse jet so attractive for all these uses is its simplicity. As shown in Fig. 1, it is just a metal tube with one-way flow check valves at the front end. (How the pulse jet operates will be fully described in SAE Quarterly Transactions.)

Though the mechanism is simple, the author points out that several problems must be solved before the above uses are realized. He clearly spells out the direction engineers must take in reducing fuel consumption and increasing valve life.

* Paper "The Evolution of the Pulsating Jet Engine and Its Future Prospects," by L. B. Edelman, Princeton University, was presented at SAE National Aeronautic Meeting, Oct 3, 1946.

Dynamometer Tests Yield

FROM A PAPER BY

G. W. McCuen*

APPEARANCE of the power-take-off dynamometer heralded a new approach to combine harvester testing. By making it possible to correlate power requirements with harvester losses in the field, the dynamometer points the way to more efficient combine harvester operation.

Not until the power-take-off-drawbar combination dynamometer came into being was it possible to measure the influence of various factors on combine operating efficiency. Height of grain being cut . . . cylinder and concave adjustment . . . speed of cylinder and combine . . . and many other factors were shown to be of importance to the farmer harvesting wheat with a combine.

In one series of tests on four varieties of Ohio wheat, both power requirements and machine efficiencies were observed. Fig. 1 shows the power-take-off dynamometer at work.

The wheat was grown on large plots in the same field that had a fairly uniform soil fertility level. Each of the four varieties was harvested with only an adjustment for height of cut being made – a common practice among operators. Data compiled in these tests are shown in Table 1.

Study of these test results revealed several interesting facts. The data show cylinder or threshing losses to be consistently smallest of the machine losses. The other two are rack and shoe losses.

Fixed cylinder-concave adjustment used for Trumbull wheat – a hard threshing type – was too wide for this variety. Cylinder efficiency increased as the volume of straw increased since the space between cylinder and concave lessened to give better threshing.

Practice of many operators of not making concave adjustment when switching to different varieties is unwise, these tests show. Closer adjustment of cylinder and concave can decrease rack and shoe efficiency by greater break-up of straw.

When grain is cut low, rack efficiency decreases because of the greater amount of straw the rack is required to handle. Rack efficiencies for Trumbull and Thorne – varieties that separate easily – increase as the length of the straw put through the machine decreases.

Losses over the shoe are definitely influenced by the amount of material delivered to the sieves. When the grain is cut low, possibility of overloading the shoe with green material and broken straw increases. It is true for nearly all varieties that the greater the volume of material passing through the cylinder, the greater the amount of broken or chipped material.

Height of cut influences the volume of straw somewhat which in turn slightly increases the power required. This increase is not significant when ground travel is constant. (These tests were run at approximately 2¾ mph.)

Rate of ground travel wields far greater influence on efficiency and power requirements of a combine harvester than does height of cut. Table 2 gives results of tests at varying speeds on a machine in good adjustment.

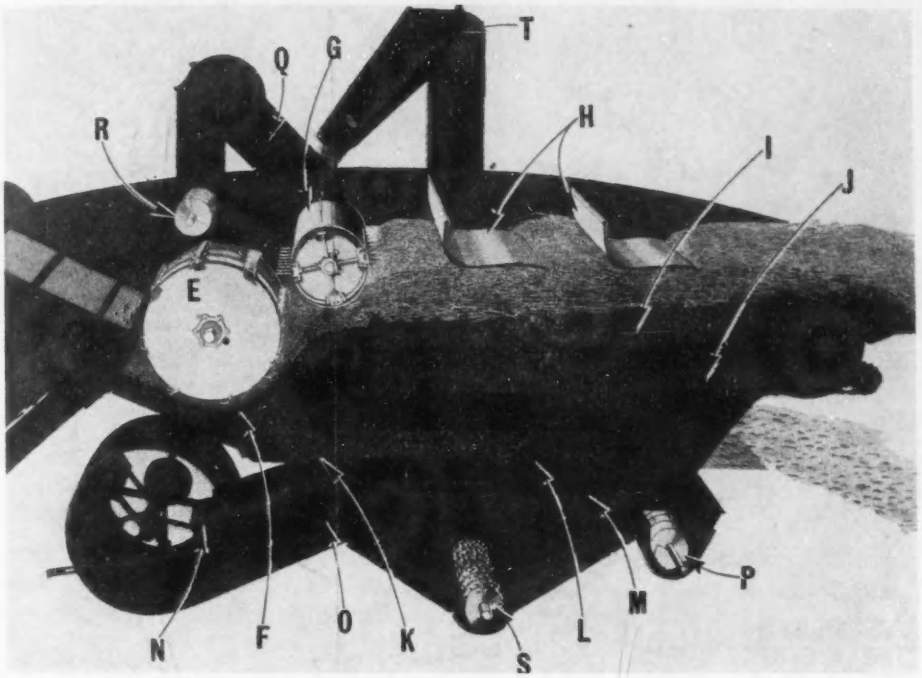
It shows that tons-per-hour of grain and straw

* Paper "Some Power Requirements Studies with Ohio Power-Take-Off Dynamometer," was presented by Prof. McCuen, chairman of the Agricultural Engineering Department, Ohio State University, at the SAE National Tractor Meeting, Sept. 11, 1946.

Table 1 – Efficiency and Power Requirements of Combine Harvester as Affected by Variety of Wheat and Length of Straw Threshed

Variety	Length		Pounds per Acre		Pounds of Grain Lost per Acre				Power-Take-Off Horsepower
	Stubble	Straw	Straw and Wheat	Wheat	Cylinder	Rack	Shoe	Total Machine	
Fulhio	6.6	35.4	5060	1956	0.8	13.2	5.2	19.2	18.50
	8.0	34.0	4810	2019	1.0	10.0	4.5	15.5	18.45
	12.2	24.8	4480	2110	1.0	10.0	5.5	16.5	17.82
	14.6	27.2	4140	1970	1.4	12.9	3.0	17.2	18.20
Gladden	6.0	42.0	6220	2618	1.0	20.2	4.2	25.4	19.58
	9.0	41.0	6336	2982	1.3	19.5	6.8	27.6	19.25
	12.0	38.0	5320	2795	0.8	18.3	5.0	24.1	18.68
	15.0	33.0	5670	2950	0.8	22.5	8.2	31.5	19.65
Trumbull	6.0	38.0	6000	2262	4.0	25.0	6.2	35.2	19.60
	9.0	35.0	5670	2560	3.3	19.7	5.1	28.1	18.80
	12.0	32.0	5000	2618	3.2	11.2	5.3	19.2	17.72
	14.6	29.6	4120	2285	2.3	8.7	4.5	15.5	17.48
Thorne	5.5	37.5	5950	2150	0.9	28.0	5.7	24.6	18.80
	9.1	33.8	5310	2398	1.1	16.8	3.2	21.1	18.25
	12.3	30.7	4120	2050	1.0	9.5	4.0	14.5	16.71
	16.0	27.0	3590	1862	0.6	9.5	3.5	13.6	16.90

More-Grain-Per-Acre Harvesting Techniques



How threshing losses occur in a typical combine harvester, such as the one illustrated, can best be seen by reviewing the machine's threshing process.

The freshly headed wheat (or similar grain) drops to the cylinder, E, which rotates in a counterclockwise direction. In passing through the meshing teeth of the cylinder and concave, F, grain kernels are separated from the straw. Grains not removed from the straw are the cylinder losses.

The threshed straw is carried over a grate to a beater, G, which attempts to remove remaining grain in the straw by agitation. Straw then moves to the rack, I. Loose grain not removed in passing over the rack constitutes the separation or rack losses.

Grain shaken loose from the straw is passed back on the return grain conveyor, J, and joins the threshed grain at the cleaning or shoe zone. (K is the shoe pan.) A blast of air from the cleaning fan, N, acting on the sieves, M, cleans the grain of the chaff. Waste over the sieve is the shoe loss, third of this machine's losses.

The finished grain auger, S, conducts the cleaned grain out of the machine for bagging.

delivered to the machine increase proportionately to increase in rate of travel. Machine efficiency was not materially changed until a high rate of travel was reached, badly overloading the rack. Inefficient separation under this condition boosted power requirements.

Correct cylinder speed also bears directly on efficiency and power requirements. Tough grain requires a high cylinder speed; dry grain can be harvested efficiently at lower speeds. Cylinder or threshing efficiency increases with cylinder speed – but so does cracking of grain.

With excellent grain conditions, increased overall machine efficiency can be expected. Decreased cylinder speed brings with it increased efficiency as well as decreased horsepower requirements, the data in Table 3 indicate.

Table 2 – Efficiency and Power Requirements of a Combine Harvester as Affected by Rate of Ground Speed

MPH	Grain Cut In Tons per Hr	Pounds Grain per Acre Lost				Power-Take-Off Horsepower
		Cylinder	Rack	Shoe	Total	
2.71	4.69	0.06	13.5	3.5	17.8	18.20
3.62	5.51	0.06	16.0	3.8	20.4	20.90
4.58	7.10	0.06	38.1	4.0	42.7	25.15

Table 3 – Efficiency and Power Requirements of a Combine Harvester as Affected by Cylinder Speed, Rate of Travel, and Constant Height of Cut

Cylinder Rpm	Pounds Grain per Acre Lost				Power-Take-Off Horsepower
	Cylinder	Rack	Shoe	Total	
1729	1.15	12.17	8.15	21.47	18.95
1500	1.71	11.40	7.00	20.11	17.41
1248	2.07	4.62	2.45	9.14	15.53

Fig. 1 – The power-take-off dynamometer in action during wheat harvesting tests

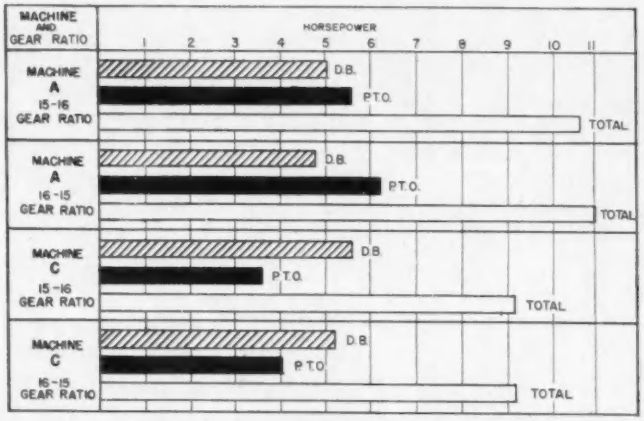


Fig. 2 – Changing the gear ratio of a corn picker does not materially change total horsepower requirements

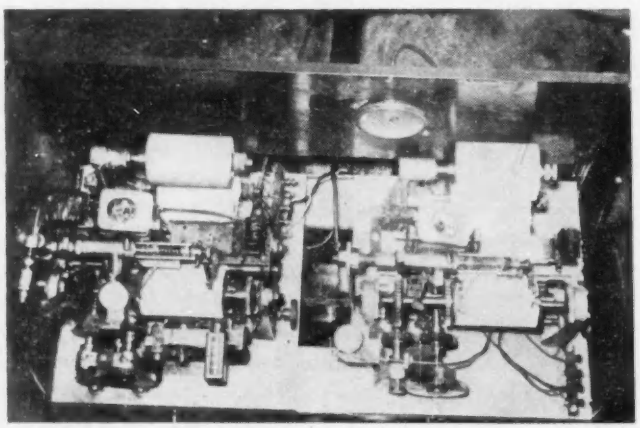


Fig. 3 – Recording mechanism on the dynamometer gives a running record of data required for power calculations

Corn picker work during the 1943 harvesting season revealed interesting facts relative to power requirements of different size pull type pickers.

A series of tests on three different sizes and types of machines was conducted to determine whether field conditions make any appreciable change in power-take-off requirements of the machine. No-load tests were conducted in both the field and laboratory.

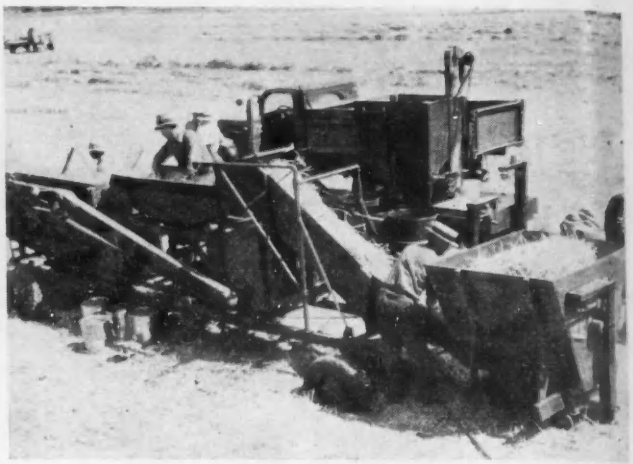


Fig. 4 – Grain losses have to be rethreshed to separate them from the straw

Table 4 – No-Load Requirements of a Corn Picker Laboratory Versus Field Tests

Machine	No-Load Power-Take-Off Horsepower		Horsepower Load in Field	
	Laboratory	Field	Drawbar	Power-Take-Off
A	1.65	2.67	1.48	9.22
B	3.13	4.21	2.05	9.28
C	2.03	2.91	1.22	5.44

The no-load field test consisted of pulling the picker over the ground where the corn had been previously harvested. No material was allowed to pass through the picker.

Table 4 shows that slight frame distortion of the machine caused by passing over uneven ground, increased power-take-off requirements of all machines.

Another interesting set of facts was obtained in a study of operating gathering chains and snapping rolls effects caused by a change of the gear ratio drive for these units. Fig. 2 shows that total horsepower requirements of the power-take-off and drawbar were practically the same for each machine when the 15-16 gear ratio was changed to a 16-15 ratio. Drawbar horsepower decreased in each case and power-take-off horsepower increased. Greater speed of the gathering chains and snapping rolls evidently caused a pull on the picker, changing the power demand relationship – but not materially affecting total power requirements.

Making all these tests possible was the power-take-off dynamometer. It is sturdy enough to take field punishment and give reasonably accurate results for comparison and correlation of power requirements and combine losses. A full recording is made of the power-take-off torque, shaft speed, drawbar pull, distance traveled, and time of run. A continuous record also is made on sensitized

concluded on page 64

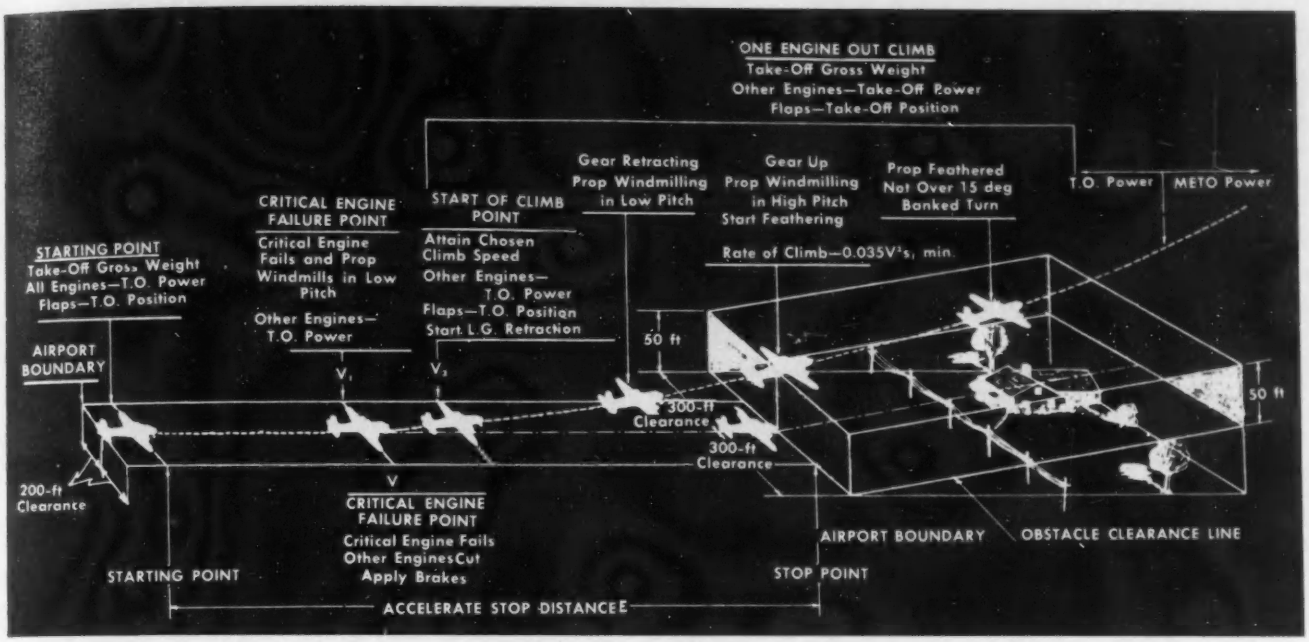


Fig. 1 – This shows how "T" category regulations apply to take-off on a typical airport

New CAA Rules Foster Greater Flying Safety

Excerpts from paper by **R. W. Ayer and F. F. Fennema***

CAA's new rules on air transport operation and design are hailed by Messrs. Ayer and Fennema as a boon to commercial aviation. They show how the public, pilot, air line operator, and aircraft designer will benefit from this new philosophy in government regulation.

REPLACEMENT of outmoded regulations governing aircraft design and operation by the Civil Aeronautics Administration's "T" category rules cut loose the shackles tethering air commerce. It began an era of common horse sense applied to scheduled airline operation, an era of more uniform yet vastly increased safety based on simple engineering principles.

These transport or "T" category rules are really very simple. They are based upon the same procedure you would use were you to build a boat in your cellar. You would measure the door and build the boat slightly smaller than the door. This is applying a yardstick rule to the manufacture of the boat.

The "T" category rules apply the same kind of yardstick to the safety of operation. They say, for instance, that "the airplane shall be able to get out of the field." As to landing, they say "the airplane shall be able to get into the field." On climb rules they say "the airplane shall be able to miss all obstacles during its climb and shall be able to stay above the terrain until it lands." That's really all there is to these rules governing safety of airplane operation.

Let us now see what they have done to operators during this last year's transition while they were going into effect.

First and most obvious effect of the regulations has been to permit the use of variable gross

* Paper "The Effect of the New Civil Air Regulations on Scheduled Air Transportation," presented by Messrs. Ayer and Fennema, of American Airlines, Inc., at the SAE National Aeronautic Meeting, Oct. 4 1946.

weights depending upon the type of operation, the length of the fields, the size of obstacles around the fields, and the height of terrain along the route.

Second and equally important effect has been to awaken the whole industry – not just the airline people – to the economic value of precise performance measurement.

Third but not less important effect of the new regulations has been the freedom of design incentives, no longer blocked by an iron-clad weight that the designer may not exceed under any circumstance.

Fourth and decidedly long-term effect of the regulations will have been a blank check to the designer to give us a truly economical airplane. An airplane that can carry all of the payload under all circumstances is permitted within the structure of the performance requirements.

Fifth effect, often erroneously thought to be unrelated, is that the new airplanes blossoming out under the new regulations will be easier to handle in the air and on the ground. In fact, they will be so much easier to handle that the direct effect is an immediate contribution to an increase in the safety in these regimes where handling qualities are the prime factors.

Compliance Adds Costs

Sixth effect (and needless to say they cannot all be good) is on the debit side. Compliance with the transport category regulations has increased the cost of operating an airline by increasing the number of personnel required both to work out means of complying and to see that compliance actually is effected. Offsetting this increased cost of operation, however, will be the increased revenue capacity of the eventual airplanes.

Seventh and last major effect, and one which is most difficult to evaluate, is the very necessary increase in power called for by the sliding scale of climb requirements in the regulations. At first glance, this might appear to dictate overpowered, uneconomical aircraft. But it is most certainly true that if we permit steady improvement in airplane cleanness, as the "T" category regulations now do, aircraft will be designed to operate most efficiently when considering the power installed.

Now let us go back and amplify these various effects with some explanations.

The first effect mentioned was that of variable gross weights, depending upon the many factors of a particular operation. There are several ways by which this gross weight is permitted to vary within limitations that permit, under any normal emergency, the maintenance of safe, free flight.

Fig. 1 is a graphic representation of the take-off yardstick rules applied to a typical airport. The airplane is assumed to start its take-off at the end of the runway and to have an engine failure at the critical-engine-failure point. Incidentally, this engine failure must be assumed to occur at not less

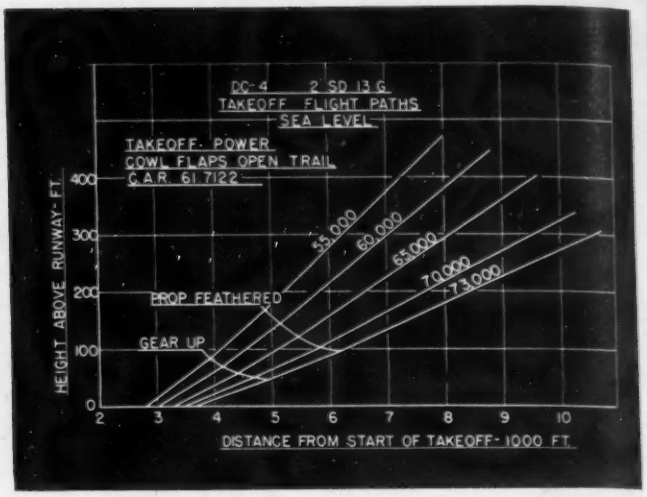


Fig. 2 – How important obstacle heights are, is demonstrated by this chart for a DC-4. A 50-ft tree at the end of the runway can carve 9000 lb of payload from a 65,000-lb airplane

than the minimum controllability speed as determined by other flight tests. From then on it must be possible either to climb out along this path or stop within the airport boundary.

It is easy to visualize the test procedure to establish the distance to accelerate to this speed and to stop thus. It is a little more tricky, however, to establish the climb-out path which is specified to be as follows:

The airplane between the critical-engine-failure point and start-of-climb point is assumed to be accelerating under its remaining power. It is permitted to start the gear retracting at this point and to start the climb with the propeller windmilling in low pitch. To give the pilot time to catch his breath and do the many emergency things required, it is assumed that the feathering operation will not be started before this point, which is 50 ft above the airport surface or at the time the gear is retracted, whichever is later.

Thus by a series of flight tests, we have established a flight path of which the airplane is capable and which in turn establishes a length of field, variable only with altitude, wind, and height of obstacle at the end of the field. After leaving the airport boundary, the airplane is required to have at least a minimum climb rate of 0.035 times its stall speed squared in the take-off configuration. It must also, during this climb-out, be able to maintain a 50-ft clearance above all subsequent obstacles and 300 ft horizontally without banking more than 15 deg.

To give you an idea of the importance of obstacle height at the end of the runway, we plotted against it the distance it takes to get over it from the take-off point, as shown in Fig. 2. Here you will notice that if we have zero obstacles and are required only to be at 50 ft at the end of the runway, it will take 4300 ft for a 65,000-lb weight. But if we don't chop down some 50-ft trees at the end of the runway, it will either take us approxi-

mately another 1000 ft of runway length or will cut us down from 65,000 to 56,000 lb.

This gives you an idea of the value of a tree when it is located at the end of the runway. To some it may seem silly; but it certainly wouldn't to the pilot, who, in the absence of these rules and precision flight tests, is trying to guess whether or not he can quite make the grade over that tree.

Much the same kind of rules are applied to landing, and the gross weights vary in the same fashion. The rules differ in that they take adequate account of an approach with one engine inoperative, requiring sufficient climb ability to pull out in the event of a missed approach. They also allow for a lack of precision longitudinally – fundamental in landing an airplane – in that they tack on an arbitrary margin of 67% on the length of field that the airplane actually requires.

There are further safeguards in the approach in that the test pilot, in establishing the airplane's performance, is not allowed to do any fast and fancy maneuvers to get in short. He must come in at not less than 1.3 times the landing stall speed and he must not duck the nose down just as he gets over obstacles and dive at the field. In other words, he must do as the average airline pilot would do.

Second effect is the awakening of the industry not only to the need for precise performance measurement, but also to its value. A great many of you probably know of the vagaries of tagging climb performance with the right number. I have heard the designer of some of our country's best military aircraft say that he has yet in his 20 years of experience to be really sure of a climb figure. And heaven knows, during the war at least, he had every form of instrumentation available to him.

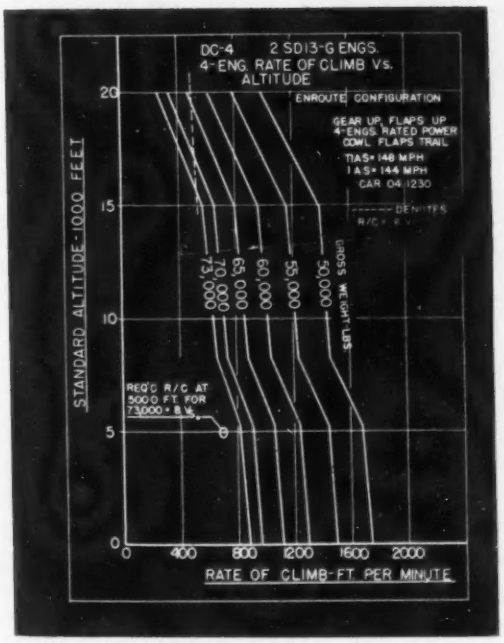


Fig. 3 – A 10% error in climb rate can cost as much as 20% of the payload

Fig. 3 shows typical climb rates with all engines operating on the DC-4. The required climb rate is almost a fixed value. If the test crew were to make an error of 10% or 120 ft per minute in this region, it would cost the airline – every time it made a trip which was limited by this climb – roughly 3500 lb of gross weight or about 20% of the payload.

The third effect of the new regulations on airline operation mentioned earlier had to do with the freedom of design now available when no inexorable weight limit is needed. You who have been in design departments of aircraft manufacturing know only too well that many pieces of an airplane are designed first to a weight figure, and then second to operating reliability, cost of manufacture, and ease of maintenance. Given a world in which every designer is 100% conscientious, there still are bound to be, under this circumstance, components designed into aircraft that are unduly affected by the weight limitation.

Imagine now a design department in which the directive says the first objectives are operating capability and reliability right along with ease of maintenance, because they are one and the same. Then second to that, efficiency of design in which the designer can take great pride, and which will inevitably result in the lowest reasonable weight for the job to be done. This kind of a directive is now possible in a design department.

Better Aircraft Will Emerge

Many will deny this statement, feeling that there still is a top structural weight, a top performance weight, and many other limitations on the total weight of the airplane. Yet it is our firm conviction that the airline airplanes that will succeed best and will give the most service to the public are those whose components are designed with this kind of a directive.

A few honest pounds of payload lost when put into a sound, safe operating mechanism, are pounds and dollars well spent – in fact may return many more dollars in operating safety. For the first time in the history of regulations with respect to airline aircraft, we have the opportunity gradually to build airplanes with this kind of a directive.

Fourth effect of the regulations on airline operation is the opportunity the preliminary design department has to conceive an airplane whose limit to its payload will be determined only by performance – not by an unduly small cabin. Today such airplanes are in the process of being born. Tomorrow will show the terrific economies available with such airplanes. And when we say economy, we do not necessarily mean low operating cost but rather a high ratio of operating revenue to operating cost.

It seems so obvious to us in the airline business that an airplane cannot afford to be what we call space limited. That is why we are frequently surprised to find designers who tend to jell the size of their fuselages at a very early stage in the preliminary design. With the present structure of the regulations, it will benefit the operators and the public if the designer always can provide a small but safe margin of cubic content over and above the maximum the airplane can conceivably carry in terms of its structural and performance weight limits.

It is easy to say that we should do this, but it is not so easy to do. It presupposes a knowledge on the part of the designer of the intended operation of the airplane, or of all its possible uses, before a sound decision on necessary fuselage capacity can be made.

Be that as it may, we believe that the day of fuselage designed to a desirable aerodynamic contour and size is gone. Instead the fuselage must be wrapped around the required space that the maximum payload will occupy. There will be exceptions to this in cases where the airline feels it can afford to charge extra fare for extremely high speeds and thus make up for the lack of seats available.

Fifth effect of the regulations on airline operation was that of raising the general level of the handling qualities. No effect could be greater on airline safety than that brought about by giving the pilot a trustworthy airplane.

Many Hazards Deceptive

Sometimes we think of handling qualities as the usual stability and controllability requirements. By no means are the handling qualities needed by the airlines restricted to these. A remark was made by a well-known engineering airline vice-president to the effect that a satisfactorily operating windshield wiper that would extend the pilot's visibility in rain and slush could be worth an incalculable amount in safety to an airline. This is just one of a host of seemingly minor items which in the designer's eye may be only annoying to the pilot, but any one of which can be lethal in its effect when it turns up in an emergency.

Just the location of the feathering button or a fire extinguisher handle, or the possible close resemblance of a flap operating handle to a landing gear operating handle can spell the difference between a serious accident and calm, reassuring operation of the aircraft by the pilot.

More and more we are going to see rules and regulations which will attempt to prevent serious errors of detail design. They never will do the whole job. Only great care in the design stages can ever hope to give the pilot an airplane with a set of handling qualities that make the airplane safe to operate under every conceivable emergency condition

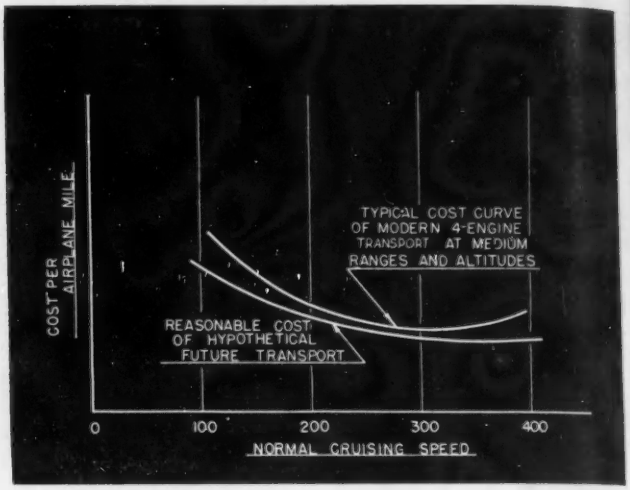


Fig. 4 – Present trends seem to indicate that airline flying costs will decrease with the advent of faster transports

The sixth effect on airline operation of the new requirements is the extra cost of compliance with the requirements. It is a complicated and tough job, just one of many steadily increasing costs which tend to frustrate an operator in his search for – let's say – a "three-cent" airline.

Seventh effect is the curious and frequently unbelievable fact that airline operating costs appear to show a reasonably steady trend downward with increased airplane speeds. Couple this with the fact that the flying public not only wants to get there fast, but in some instances may pay extra fare for the extra speed, and we have a theoretically optimistic view of high speed airline aircraft.

The curves in Fig. 4 will bear very little scrutiny. We would hesitate to answer were one to ask what quantitative values to put on them. However, they do give you an idea of what we think the cost picture may be with respect to airplane speed, if everything else remains equal. The lower curve is a wild guess on an airplane with a new type of powerplant – perhaps a turbine.

We don't know whether the bucket at 300 mph on the top curve should be at 300 mph or 400 mph. We only have data that give us an inkling of the probable trend. At least we can be reasonably sure that there will be a slight upward trend in costs as we get up to the 400 mph region with the conventional airplane.

This is an important factor if it is related to the T category requirements, which in themselves have a tendency to require a low power loading (pounds per horsepower). It means that the operator has two incentives pulling him in the same direction: (1) compliance with the minimum performance of the T category, and (2) a desire to get a more economical airplane through high speed, which in turn inevitably connotes a low power loading.

It is last but not least significant to note that many of the effects of the "T" category requirements on airline operation come indirectly through their effect on the original design.

Note to: Aircraft Industry On the Job Ahead

FROM A PAPER BY **H. N. GILBERT***

APPRAISAL of the aircraft industry's experience in the recent war spotlights production and engineering as the key to postwar survival and success. Each company can enhance its chances by deemphasizing production without dropping the rich reservoir of manufacturing know-how amassed and by striving for engineering competency.

Excellent manufacturing practices remain as a heritage of war; but without high volume production they can be an expensive way of doing business. Production rates of 20 airplanes per day called for hard dies, simple assembly operations, mobile jigs, and moving assembly lines. Yet these very features that only a few years ago stood out as a life line to victory can now be a mill stone around the manufacturer's neck.

But many production features can be carried over by the industry. Long strides were made in tooling – the heart of big league aircraft manufacturing. All companies made marked progress in fabrication and assembly of tooling, and in devising a system for master tools and gages to keep production tools within tolerance.

Production planning and cost estimating techniques developed during the war should enlighten sales departments in an area of prewar embarrassment. Manufacturers became aware, for the first time, of such devices as learning curves – rate of reduction in manhour costs – and obtained factual data on the number of manhours put in each pound of airframe weight. Learning curve records now exist for heavy bombers, transports, and light aircraft.

This knowledge provides the aircraft builder with a starting point for breaking down his costs and coming up with reasonable estimates. But he must combine common sense with these standards to avoid serious pitfalls.

The engineering lesson driven home is that design and development of high performance aircraft require highly competent engineers and engineering administration.

We've learned that transition from design conception to commercial exploitation remains a long and thorny path. Despite the tremendous concentration of effort on design of new military aircraft during the war, the fighting ended with planes designed before our entry into the war. This proved to be naive the belief that the time cycle for development of new airplane types could be shortened.

Further testimony supporting this thinking lies in the financing of a new development. Creation of a new airplane design is a terrifically expensive matter. No financial crisis appears imminent because high-performance models – especially transports – now being sold to the commercial market were developed at Government expense.

Now that the industry will be standing on its own feet, it must bear the financial risk of new designs. Making sales from blueprints instills a false sense of security; there is bound to be many a slip betwixt performance on paper and performance in the air.

But the war did demonstrate that tremendous technical improvement is possible in existing airplane designs. An airplane is a complex machine and certainly optimum performance is not achieved in the initial design. Concentrating on engineering refinements of production models will pay dividends.

War experience pointed up the importance of effecting a sound system for introducing engineering changes into airplanes on the production line. Few succeeded in working it out in wartime and the problem still exists in peacetime. Commercial transport manufacturers are faced with the prospect of making changes during the manufacturing process to reflect both each customer's individual requirements and design improvements stemming from operational experience. Such a system must be effective and, above all, cheap.

Each company's realignment of the production and engineering function should involve an organizational reshuffling – from top management down. Deflation of manufacturing should bring a corresponding reduction in the production force. How much of a reduction depends upon the individual company and its plan of operation.

Aircraft companies are returning to prewar organization – built around a nucleus of high calibre engineers capable of designing superior products. But prewar companies will look crude by comparison. The manufacturer of tomorrow that survives keen postwar competition will have hit upon the right formula for combining engineering competency and manufacturing efficiency.

* Paper entitled "Postwar Aircraft Industry Cashes In on Wartime Experience," was presented by Prof. H. N. Gilbert, of the California Institute of Technology at the SAE National Aeronautic Meeting, Oct 5, 1946.

Why Airliners S
Fluorescent L

1 This was an attempt to illuminate the cabin interior and maintain a low ceiling surface brightness using incandescent lamps in side fixtures. The installation was unsatisfactory because the high surface brightness reflections above the fixtures were as annoying as overhead fixtures . . . perhaps even more so

2 Demonstrated here is an indirect lighting installation using skylight type fixtures, each equipped with 21-cp incandescent lamps. It provided a high level of illumination. But the surface brightness ratio between the fixture and the poorly lighted ceiling was too great. Result: discomfort to passengers' eyes

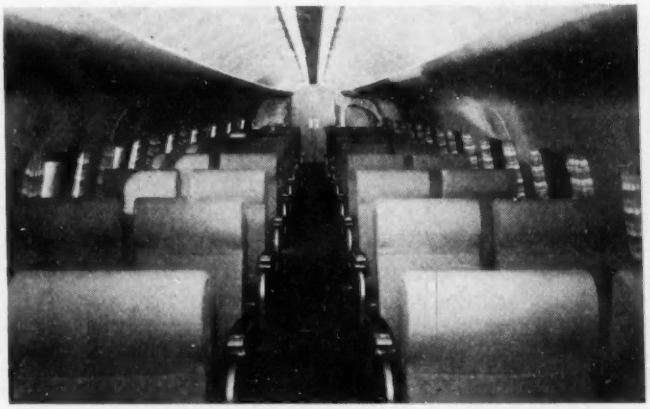
ILLUMINATING commercial aircraft interiors with indirect fluorescent lighting points the way to greater passenger comfort.

These lamps make it possible for the passenger to see color and detail of objects in his field of view without eye discomfort.

That fluorescents are superior to incandescents in many respects has been proved by numerous test installations in a Curtiss Commando cabin mock-up. The illustrations on these pages demonstrate some of these advantages as well as several design features that produce better lighting.

What the pictures do not convey is a comparison of appearance. Only an inspection of the airplane's cabin interior can reveal the pleasing difference in color detail and freshness of fluorescent over incandescent lighting. Incandescent lighting has a distinct yellow color while fluorescent lamps produce a clear blue-white light that includes some red and yellow, depending on the type of lamp selected.

Fluorescent lamps also produce a steadiness of



3 But good results can be obtained with indirect strip-type installations equipped with fluorescent lamps. Appearance of the ceiling and reflection strip is such that the brightness from the reflection strip is not more than ten times greater than the ceiling brightness—an objective to strive for in aircraft cabin lighting

4 This is a close-up of the installation at left. Basic design consists of a line of tubes covered by a strip-type reflector that directs light to the corrugated plastic panels fastened to the ceiling on each side of the fixture. This photograph illustrates the snap-type fasteners that allow the fixtures to swing down for cleaning, servicing, and lamp replacement

Should Have Lighting

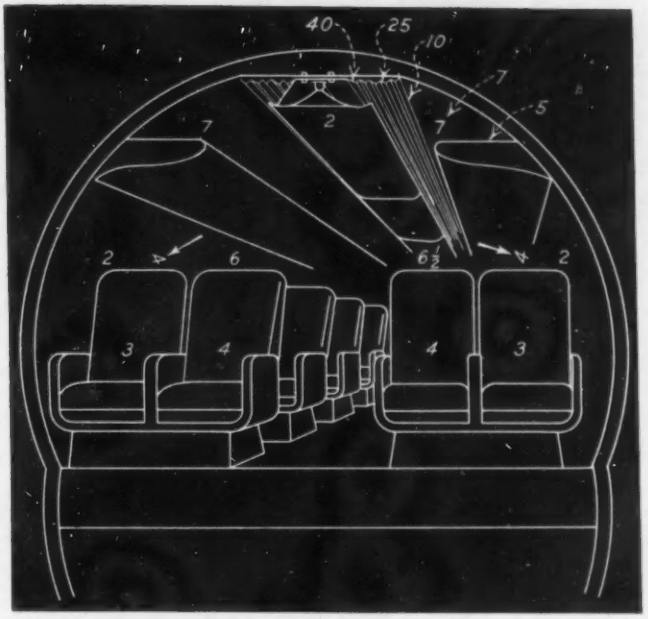
FROM A PAPER BY **R. A. RUGGE***

lighting not possible with incandescent lights. It's an accepted fact in electrical engineering circles that a 1% decrease in voltage will produce approximately a 3% decrease in incandescent lamp output, but only about 1% decrease in the fluorescent lamp's output.

Final evidence in the case of fluorescent versus incandescent that leaves no doubt as to the verdict is cost . . . fluorescent installations are much cheaper. Data from tests conducted by both Curtiss-Wright and lamp manufacturers, shown in Table I, drive home the cost comparison.

Probably the most controversial factor in this comparison is the difference in weight of the two systems. Studies show a fluorescent lighting installation to be 3.2 lb or 20% heavier in weight than a comparable incandescent installation – a small price to pay for fluorescent lighting benefits.

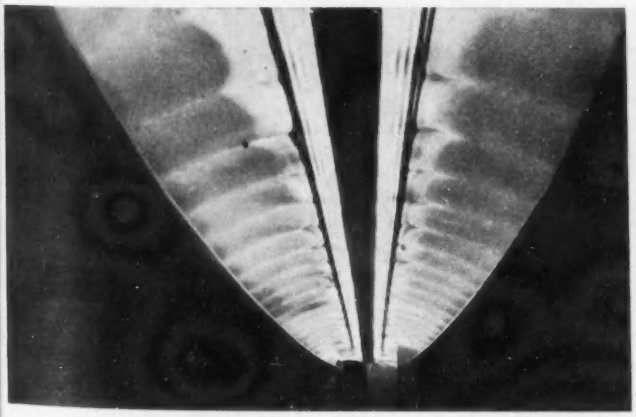
* Paper "Fluorescent Lighting for Commercial Airplane Interiors," by R. A. Rugge, staff electrical engineer, Curtis-Wright Corp., was presented at SAE National Air Transport Meeting, Dec. 5, 1945.



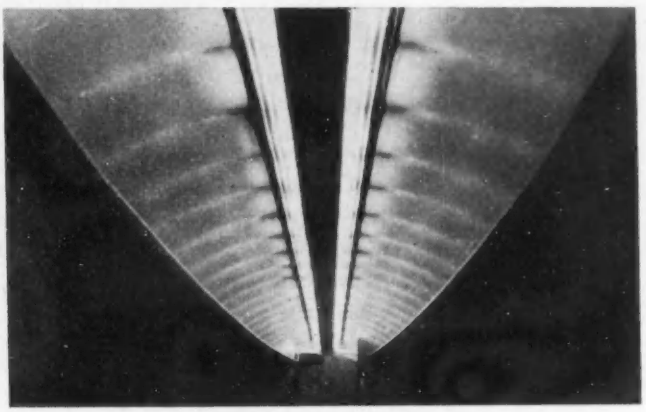
5 Relationship of illumination levels produced by a strip lighting fixture (shown in 3 and 4). Notice that the range in illumination values on objects comprising the central field of vision vary from 4 to 40 ft-c. Exceptions are illumination values from lower surface of the fixture and top and lap level of the outboard chairs. Although these imperfections should be corrected to be within the 10:1 ratio for best eye comfort, they are not considered too detrimental to the overall lighting scheme

Table 1 – Comparison of Fluorescent and Incandescent Lighting Cos

Type of Lighting	Burning Life	Lamp Cost	Lamp Cost per 100 hr of Life
Fluorescent F-15 (T-8)	2500 hr	83¢	3.3¢
Incandescent Mazda 307	300	42¢	14¢
Difference in Percentage Compared to Incandescent	+733%	+7.6%	−76.4%



6 The photograph at left shows an incandescent lamp installation and the one at right shows the same type of installation equipped with fluorescent lamps.• Comparison of these two



7 pictures reveals that uneven light distribution, striations, and waterline patterns are defects noticeable in the incandescent system not produced by fluorescent lighting

Vibration - Density

BASED ON PAPER BY

A. S. Fry, J. Stone, and L. Withrow*

COMBUSTION roughness resulting from flywheel vibration can better be remedied over the entire speed range by changing vibrational characteristics of the flywheel than by redesigning the combustion chamber or relocating the spark plug to alter pressure-time relationships, Messrs. Fry, Stone, and Withrow believe as a result of recent vibration studies.

They admit that combustion chambers can be designed which will limit rates and accelerations of pressure rise to values where flywheel excitation is slight at low speeds. But at high engine speeds, maximum pressures must be lowered if vibration is to be diminished. This can be accomplished, for example, by retarding spark advance or by reducing volumetric efficiency.

But a suitable damping system appears to be a more practical way of controlling vibration.

Supporting this belief are calculations which show that engine operating speed determines vibrational response of the flywheel to combustion pressure characteristics. *In a paper published in full in the January 1947 issue of SAE Quarterly Transactions*, the authors disclose that at low engine speeds, rate of pressure rise governs vibration intensity, whereas at high engine speeds, maximum combustion pressure determines intensity.

Method of Analysis

These conclusions were drawn by the authors from a study in which response of the flywheel to a given pressure-time card was accurately calculated by a procedure based on experimental data. The data used in this analysis were from a single-cylinder engine and a 1941-Oldsmobile 8-in-line engine. A number of pressure-time cards comparable to those from actual engines were synthesized. As far as possible, maximum pressure, its rate of rise, and acceleration and deceleration of rise were varied independently and only during the combustion period. Before and after combustion, the exponential relationships between combustion-chamber volume and pressure – relationships taken from observed cards – were held constant. It was assumed that clearance volume remained fixed and that at a given speed the same quantity of charge was burned in all cases. Experimental data justified the assumption that damping is of the viscous type. That is, the tilting motion of the flywheel about a horizontal axis is opposed by a torque proportional to angular velocity of tilt.

The response of the flywheel is reported in terms of a hypothetical restoring pressure which is equal to a hypothetical force – the force acting on a rigid lever attached to the flywheel which would produce the elastic restoring torque actually due to crankshaft deflection – divided by the piston area. The use of this restoring pressure simplifies correlation of flywheel response with combustion pressure.

Fig. 1 compares synthesized pressure-time cards and resulting flywheel vibrations with oscillograms taken on the Oldsmobile engine.

Maximum kinetic energy has been found to be the most suitable criterion of the vibrational disturbance. (The greater the vibration and its fellow-traveller, roughness, the greater the maximum kinetic energy.) This quantity is defined as the product of one-half the square of the maximum velocity of flywheel tilt and the moment of inertia about an axis passing through the rear main bearing and normal to the crankshaft axis.

Effect of Pressure Functions on Roughness

Maximum Pressure – A marked contrast is apparent in the comparison at two different speeds of the effects of maximum pressure on engine roughness as calculated for the Oldsmobile engine. At 3500 rpm, a threefold rise in the maximum values of kinetic energy is produced by a 20% rise in maximum pressure. At 1000 rpm, the maximum kinetic energy is roughly proportional to the maximum pressure. These results are confirmed by actual experience with the 1941-Oldsmobile 8-in-line engine. At 3500 rpm, the engine becomes

*Paper "Analysis of a Shock-Excited Transient Vibration Associated with Combustion Roughness," by A. S. Fry, deceased, and J. Stone and L. Withrow, Research Engineers of Research Laboratories Division, GMC, was presented at SAE Summer Meeting, June 6, 1946.

-Combustion Pressure Relationships

rough as the throttle is opened and maximum combustion pressures increased.

Rate of Pressure Rise – With the operating speed held constant at 3500 rpm, the rate of pressure rise was increased from 12.5 to 123.0 psi per crankshaft deg. The result was a slight decrease in kinetic energy from 0.074 to 0.057 ft-lb.

Only at low speeds and at low rates of pressure rise do the effects become appreciable. At 1000 rpm, increasing pressure rise rate from 7.5 to 23.0 psi per deg increases kinetic energy from 0.006 to 0.059 ft-lb. Further increases in the rate of rise from 23.0 to 93.5 psi per deg merely increase kinetic energy from 0.059 to 0.072.

It is impossible to divorce changes in rate of pressure rise from changes in the other pressure characteristics. In synthesizing the pressure-time cards, it was required that magnitude and angle of peak pressure remain fixed. Therefore, increases of both acceleration and deceleration of pressure rise are involved. In actual engine practice, both the value of maximum pressure and the point at which it occurs in the cycle are altered when rate of pressure rise is varied.

Acceleration and Deceleration of Pressure Rise – At 3500 rpm, combustion roughness is not appreciably affected by acceleration of pressure rise. On the other hand, at 1000 rpm, a tenfold increase of maximum acceleration from 0.5 to 5.0 psi per deg^2 increased maximum kinetic energy from 0.012 to 0.025 ft-lb, a 108% increase. In terms of decibles, this tenfold rise in acceleration increased kinetic energy by 3.1 units.

It is doubted that deceleration of pressure rise is a factor in the control of engine roughness either at high or low speeds.

B-29 DESIGN

cont. from p. 42

even to the extent of operating "on the deck" – did not result in a proportionate improvement. In fact it resulted in no improvement at all.

Observations were then taken of humidity as well as temperature at various altitudes, and the reasons for performance results at lower altitude began to become apparent. Since the test airplane was equipped with both torquemeters and flowmeters, it was possible to check both power and fuel consumption at various altitudes using standard power settings and required cowl flap settings.

These checks showed that at lower altitudes, power was less than should have been obtained by using standard power settings, and specific fuel consumptions were higher than average. Corresponding tests were then run, increasing the manifold pressure at each rpm to obtain standard chart horsepower at that rpm setting. On these test runs specific fuel consumptions were substantially reduced.

With apparent performance discrepancies thus accounted for, and with temperature and humidity conditions known, it was then possible to prepare flight plans to take advantage of optimum operating procedures.

Bomb loads carried in initial raids from the Marianas averaged about 5000 lb.

Shortly after the completion of the theater flight test program, an AAF combat crew using revised procedures demonstrated that 20,000-lb bomb loads could be carried from the Marianas to Japan with adequate fuel reserves. A general picture of the relationship of bomb load to altitude and time is shown in Fig. 2, p. 42.

At this point in its development, the B-29 airplane as such could be said to have entered the "home stretch." A worthwhile lesson had been learned, however, a lesson that demonstrated the need for close control of weight and drag, and close correlation of airplane design and performance with actual operating conditions.

This lesson is being applied directly in the development of the successor to the B-29, the B-50. The increased power and other improvements incorporated in this airplane will result in improved performance and range while at the same time providing improved ability to "take it" under adverse conditions as bad as or worse than those which confronted the Army Air Forces during the recent war.

TRANSPORT

AIR TRANSPORT engineering enters its postwar phase with stern economics emerging as an important guide for both thinking and planning the many research and development projects in the offing.

Speaker after speaker at the SAE National Air Transport Engineering Meeting, Dec. 2 to 4, at Edgewater Beach Hotel, Chicago, reiterated that the air line industry must get down to earth in its conception of its future, and that its prospective business will be with passengers and freight shippers who have long been accustomed to rail, steamship, bus, truck and passenger car conveniences and facilities.

"Engineering has conquered time and space," 1946 SAE President L. Ray Buckendale told the noon-day banquet audience at the Wednesday session which closed the three-day meeting.

"The SAE Air Transport Engineering Activity is in key position to contribute engineeringwise to the problems created as a result of finding, within so short a time, and using shorter routes around the world.

"Yours is the newest of our professional activities," he continued. "Yours also is the newest and greatest opportunity in engineering. You serve not only your country, but the whole world."

Ground and Air Operations

Plaguing day-to-day problems of maintenance, the elaborate enterprises of redesigning existing airports and planning new ones for more efficient use, farsighted views of landing and launching transport planes from moving ground vehicles, and an insight into the prospects of transport use of helicopters were all covered in as fine a group of technical aeronautical papers as ever presented under any auspices.

More than 400 engineers from overseas and across the Continent, with a sprinkling from Canada and Latin America, representing air line operators, plane, engine, and equipment manufacturers, petroleum refiners, the civil air authorities of several countries, and the Army and Navy, gave a breadth to the discussions transcending that of any previous SAE air transport engineering meeting.

Chairmen and members of the several committees not only laid out a program of exceptional merit, but they stayed on the job and saw their schedules kept.

Observers agreed that the system of making question slips available to the audiences, and then collected by Reception Chairman Andrew Raffay, Jr., and his colleagues and read by the session chairmen, kept the discussion periods in lively cadence. General Chairman W. W. Davies instituted this plan several years ago at an Air Cargo Meeting which preceded this, the second air transport meeting of the Society.

None of the engineers present were under the delusion that achievements to date give any reason to pause. W. E. Rhoades proposed a new technical authority to employ the American town meeting techniques which would effectively, he thought, enable the eight Government and four private agencies concerned with airborne traffic and weather to reach overall decisions in the interest of orderly progression of the industry.

Some of the major technical problems faced by air transport engineers in respect to all-weather flying were outlined by the Air Transport Associa-

Warp of the Air Transport Engineering Meeting held Dec. 2 to 4 in Chicago was a series of thorough going engineering papers on recent developments – and the woof was a strong thread of economic considerations which charted priorities.

Discussion at the sessions was vigorous, and was participated in by aircraft, engine, accessory, fuels and lubricants and accessory engineers, and petroleum technologists.

The largest attendance in the history of this series of meetings agreed that air transport's future is a bright one, but it faces many basic engineering and research tasks in the years ahead.

Meeting Lays Airlines Future at Engineer's Doorstep

SAE Vice-President Charles Froesch (left) with General Chairman W. W. Davies, dynamic organizer of the meeting, and Chicago Section Treasurer P. H. Obereutter. H. S. Manwaring, Section secretary, was out of town when this photograph was taken

Chicago Section Chairman William H. Oldacre (left) with SAE 1946 President L. Ray Buckendale, and Harold R. Harris, who served as toastmaster at the dinner which closed the Dec. 2 to 4 SAE National Air Transport Engineering Meeting, Edgewater Beach Hotel, Chicago

Chicago Section Vice-Chairman for Aeronautics Daniel V. O'Leary (left) with W. E. Rhoades, dinner speaker, and CAA's Harold Hoekstra, photographed prior to the dinner

tion of America expert and George Comstock, Airborne Instruments Laboratory, Inc., at the final session of the meeting. This paper, in many respects, endorsed numerous statements during the meeting which pointed to the need of overall coordination of research and development work.

For example, the meeting started off with a paper by A. L. Morse, acting chief of CAA's experiment station at Indianapolis asking for the industry cooperation on its safety program in view of higher cruising speeds in prospect and their subsequent higher landing and takeoff speeds of tomorrow. Session chairman was C. E. Swanson.

Morse gave his listeners an idea of the scope of the CAA program, of which he is acting chief. He, like many other speakers, proved to be among the

most interesting discussers as problems were raised in later sessions.

A description of the Merlin Rolls-Royce liquid-cooled engine by J. D. Pearson, England, was read by his co-author, Eric Warlow-Davies, of Canada. Both the advantages of this type of powerplant and some of its disadvantages – as compared with the aircooled types – were explored following the presentation.

Said to be one of the most efficient maintenance operations of any airline, that of the Swedish operation was detailed by K. H. Larsson, Aktiebolaget Aerotransport, who was introduced by Session Chairman J. G. Borger. Surprisingly enough, the problem of dealing with both the inch and metric systems of measurement has presented no major difficulty to this line which uses equipment manufactured in several countries.

Envelope Ground and Air Angles

Larsson insisted that there is no substitute for the best maintenance possible. High costs, he said, are to be expected if an airline is to maintain a high record for time in the air of airplanes and top safety performance. Several American operators who had visited the maintenance plant urged other SAE members to call on the chief engineer of the Swedish line and inspect his Stockholm establishment.

His scholarly presentation of the basic engineering considerations of airport design kept Charles Froesch's audience in discussion until past 11 o'clock at the Monday evening session, directed by E. H. Sittner, chairman. It appeared to be the consensus that centralized operation of an airport is best for the smaller layouts, but operations at the larger proposed airports must be decentralized.

Practice of obtaining additional – and sometimes important revenues – from concessionaires has been so well established at airports that this has become an important consideration in any planning. The analogy between air transport and railroad and steamship operation was clearly shown when it was said that additional revenues from this source must be considered in the basic layout of the facilities pattern of airports of tomorrow.

Economics again and again raised its stern voice in the three sessions of the following day, although the titles of the seven papers covered a wide range of airports, all-weather flying, equipment, and accessory topics. Keynote had been sounded the previous day by Harold R. Harris in his discussion of obtaining the optimum aircraft utilization in both domestic and overseas operations.

The vice-president and general manager of American Overseas Airlines, Inc., declared that the minimum operational cost of any aircraft will be based on the ability to fly that airplane maximum time up to 24 hr a day, every day in the year. Therefore, he said, economics demands that airline operators minimize, in every phase concerned, the amount of time transport planes are required to stay on the ground.

Balances to achieve this condition are delicate, he warned, and no one operation can be compared accurately with another. Each route requires clear-headed engineering analysis and costly experimentation to make a good determination.

Quoting W. C. Mentzer and H. E. Nourse, the former Army Air Transport general pointed out that variation of airplane utilization has a profound effect on significant operating costs, and that airplane utilization, in terms of flying time, is fundamentally dependent upon trip length, with a secondary dependence on seasonal schedule changes, block speeds and such factors.

"An enormous gold mine remains to be worked by reducing the 16 out of every 24 hr the average commercial airplane in this country is grounded for maintenance, modification, and for other reasons," he said.

"Other things being equal, if we doubled our flight time, we could halve the number of aircraft required, and materially reduce the number of personnel on the payroll," Harris pointed out.

Paper Work Overwhelming

He surprised many of his audience by saying that each foreign departure from LaGuardia Field requires 273 documents to satisfy various Government agencies even if no cargo is carried. Each piece of cargo requires 14 documents additionally.

Operators and manufacturers alike were hauled over the coals with vigor on the excessive time being required on modifications. He said operators must insist that the manufacturer furnish aircraft and components to meet operational requirements when the equipment is delivered, and charged that manufacturers do not generally design and build components rugged enough for service.

Equipment designers, too, are prone to engineer complicated devices without considering maintenance troubles and excessive delay of the aircraft, he said, and requirements of new Government edicts.

Spare Parts Planning

Another fertile field for reducing "grounded" time is in the area of spare parts and components. Better anticipation of long-term requirements, and adequate stocking of spares at strategic points will increase flying time of air liners, he said.

It was evident that everyone present – manufacturers, Government officials, and operating engineers – was in perfect agreement with Harris' presentation, because the vigorous discussion which followed was one of engineering interpretation of economics. There was no doubt in the minds of the audience that "an airplane is no good on earth," as the author quipped.

continued on page 95

Design Technique Forecasts Supercharger Performance

EXCERPTS FROM PAPER **By R. J. S. PIGOTT**

No more hit-and-miss, cut-and-try engineering of superchargers, says Mr. Pigott in this article. He shows how losses can be predetermined so that performance of the design on the drawing board can be improved before even building a model.

Mechanical and slip losses are broken down and formulas for calculating them presented. A complete discussion is given on oil losses for common ball and roller bearing configurations including the influence of operating temperature of the lubricant and deformation of metal on bearing losses.

Both the Roots and vane types of compressors are analyzed as well as a number of component designs. Mr. Pigott winds up this article with an illustration of how calculated slip correlated with test slip in one instance.

SUPERCHARGER design requires a rational approach instead of hunches and bright ideas. Predicting performance of positive displacement compressors is now possible using analytical methods developed to define and calculate losses. This valuable tool shows the designer where improvement can be made without hunting blindly for the source of trouble.

The same methods employed by the writer for analyzing liquid pumps – when properly altered to suit compressible liquids – will serve very well. By a similar subdivision of the losses into slip and mechanical groups, the following breakdown is obtained:

Slip losses, apparent:

1. Intake side pressure losses affecting the density of the charge,
2. Real slip controlled by actual pressure difference, seal dimensions, and density.

Mechanical losses:

1. Intake and discharge side pressure loss affecting actual pressure difference;
2. Compression loss, if other than isentropic adiabatic;
3. Viscous losses – windage;
4. Bearings;
5. Pilot or other gear losses, and
6. Packing friction.

Intake losses in a liquid pump do not affect the delivery up to cavitation point except as they increase slip by increasing pressure difference; but with gases, the effect is much greater due to another kind of action. Reduction of pressure from losses in intake side of the blower, in the case of a gas or vapor, reduces the density in the impeller pockets. The result is that the displacement, which is constant at any given speed, passes a smaller weight of gas per second.

The effect is the same as a reduction of displacement when figured at intake conditions. Since this reduction of weight per revolution combines with real slip in lowering the measured delivery, it has been mistaken for slip, and consequently has very greatly confused attempts to formulate slip computation.

Neither in liquid pumps nor in superchargers has the intake loss been given any appreciable attention. It leads ultimately to cavitation in liquid pumps, and to lowered apparent volumetric efficiency in compressors. The formulation of the loss is not too difficult but will naturally vary with the particular design. Fortunately the loss can quite easily be measured by direct test.

For compressibles, the test is by varying speed and measuring the reduction in cfm delivery ex-

*Paper "Analysis of Positive Supercharger Losses," by R. J. S. Pigott, Gulf Research & Development Co., is being presented at the 1947 SAE National Meeting, Detroit, Jan. 8, 1947. It was previously presented at SAE Buffalo Section, Nov. 14, 1945.

pressed at intake conditions, with zero pressure difference between intake and discharge. It is found that the reduction of delivery is related to the intake losses, as given below. For the case of zero differential between intake and discharge flanges, slip is generally negligible.

The make-up of intake losses is as follows:

1. Centrifugal force, if entry is peripheral;
2. Skin friction, intake chamber;
3. Impact type losses due to any intake changes of flow direction, and
4. Jet losses at sharp corners between teeth, etc., including vena contracta effect.

For a Roots type, two or three lobe, taking air at the periphery, the centrifugal resistance is due to the body of air in the pockets between lobes and case, calculated as follows:

$$p_c = \frac{\rho_s(v_t^2 - v_r^2)}{144 \times 2g} = 0.000108\ \rho_s(v_t^2 - v_r^2)$$
$$= 2.960 \times 10^{-7}\ \rho_s(d_t^2 - d_r^2)N^2 \qquad (1)$$

where:

p_c = centrifugal pressure, psi
ρ_s = density in lobe pockets, intake side, lb per cu ft
v_t = tip velocity of impeller, fps
v_r = root velocity of impeller, fps
N = rpm
d_t = tip diameter, ft
d_r = root diameter, ft

Static pressure p_1 measured at inlet flange does not account for all the energy in the gas flowing into the blower; there is also the velocity head, easily calculated from Q_1/a. With the abrupt turns, occurring at inlet, it has usually been customary with liquids to consider all this velocity head lost. Apparently this is not the case with gases as some recompression occurs in changing direction in the impeller.

Exact recovery is affected by the ratio of area between intake pipe and area of port or case exposed; but for most cases it is close to ½ the velocity head. For the Roots two or three lobe type, the intake loss consists substantially of the centrifugal force less half the entry velocity head. Item 4 is absent, and item 2 is so low in all cases as to be negligible.

If we were dealing with five or more lobes, item 4 would become more and more important as it is in gear pumps, but we have no examples of this type so no time need be spent on such a construction. Fig. 1 illustrates the Roots type, and Fig. 2 the vane type.

Vane blowers have almost no centrifugal force opposing intake at the beginning of intake arc because the ring of gas between drum and case has practically zero radial depth. But at the end of the suction arc, the radial depth of air is nearly double the eccentricity of the drum to the casing and develops considerable centrifugal force.

Since this is the point at which the completion of intake occurs, the centrifugal force at this point will be controlling and will largely influence the total intake loss. If the ports to the vane pockets are sharp-edged or of a shape other than rectangular to match the blades, quite heavy jet losses may occur – especially at the finish of the intake arc when a blade is closing off the port opening.

For the screw designs such as Elliott-Lysholm and Hamilton-Whitfield, centrifugal force does not oppose intake since the impellers take air on the ends without sensible rotation. But since the screws are steep pitch for reasonable capacity, the pick-up edge is not at the correct angle and pick-up shock occurs (item 3).

Rotation of areas at close clearances obviously causes a shear resistance – viscous drag or windage – the same as with liquids in pumps; but the amounts are less with gases on account of low density.

For cylindrical surfaces the general expression for viscous condition of flow is:

$$HP = 1.752 \times 10^{-9}\ \frac{\mu w d^3 N^2}{b} \qquad (2)$$

A more convenient form for use where the rubbing surfaces are not *complete* cylinders, such as the tips of Roots impellers or blades, is:

$$HP = 5.577 \times 10^{-4}\ \frac{\mu a d^2 N^2}{b} \qquad (3)$$

where:

HP = drag hp or windage
μ = absolute viscosity fps units (= centipoises × 0.000672)
w = axial width of rubbing surface, ft
a = area of rubbing surface, sq ft
d = diameter of cylinder, ft
N = rps
b = clearance between surfaces, ft

For turbulent flow conditions, more commonly subsisting with gases than with liquids, the forms for complete and incomplete cylinders, respectively, are:

$$HP = 6.885 \times 10^{-4}\ f \rho_m w d^4 N^3 \qquad (4)$$
$$\text{and } HP = 2.190 \times 10^{-4}\ f \rho_m a d^3 N^3 \qquad (5)$$

where:

f = friction factor,
ρ_m = mean density of gas in the capillary seal,

$$\left(\text{usually } \frac{\rho_1 + \rho_2}{2} \text{ is near enough}\right)$$

For complete discs with a hole (end surfaces):

a. Viscous conditions:

$$HP = 2.190 \times 10^{-4}\ \frac{\mu N^2(d_1^4 - d_2^4)}{b} \qquad (6)$$

b. Turbulent conditions:

$$HP = 6.885 \times 10^{-4}\ f \rho_m N^3(d_1^5 - d_2^5) \qquad (7)$$

where:

d_1 = outer diameter
d_2 = inner diameter

If we were dealing with wide clearances and varying roughness of surfaces, such as might be found between a centrifugal pump impeller and

casing, it would be necessary to estimate f from the clearance b and the roughness.

But at values up to 0.015 in. for b (generally much less) even a ground surface is "rough" hydraulically; and f can be fixed at 0.054 for all turbulent region computations – a considerable convenience. It should be borne in mind that we have not the general convenience of a fixed critical range of Reynolds number at which the transition from viscous to turbulent conditions occurs, as in round pipes.

In the disc and cylinder cases, the critical range may be as low as Rn = 300, or as high as 1200. The only way to find it, on the few occasions necessary, is to calculate the loss by both viscous and turbulent formulae, plot on log paper, and get the crossing point of the curves.

For irregular end surfaces, such as the lobes of a Roots, or the ends of screw impellers or gears, the convenient method of calculation is to divide the outer 60% of the surface into five strips and use the mean arc width of each strip, instead of an elaborate integration. It is noted that under turbulent conditions 99% of the friction of such a disc is provided by the outer 60% of the radius, and it does not matter appreciably whether the disc is solid or has a shaft or hole up to 40% of the outside diameter. This is more or less obvious from the fifth power of diameter in formula (7).

Most of the positive superchargers use ball or roller bearings. The three kinds of losses that may occur with rolling bearings are:

1. The rolling loss due to deformation of the metal, accompanied by some sliding;
2. Viscous loss due to the lubricant shear effects, as in a sleeve bearing;
3. Turbulent loss due to paddling the lubricant, for a flooded or submerged bearing.

It is not generally recognized that since a ball and race deform under load, some sliding action always accompanies the rolling. This is why a ball or roller bearing must be lubricated.

If pure rolling subsisted, no lubricant would be required; but we all know a ball bearing will not operate dry, although it generally needs very little lubricant. Torque resistance from rolling varies as the 1st power of load for roller bearings, the 1.5 power for ball bearings, and also with the size for the former.

Viscous shear losses are like those in a sleeve bearing and are due to close fits between cage and balls or rollers, and to some sliding in the rolling surfaces. Obviously viscosity of the lubricant will appear as 1st power in the viscous loss, size as representing the area of rubbing surfaces, and rotational speed as about the 2nd power.

Third type of loss ordinarily does not appear in supercharger bearings, as they are never operated flooded. This case generally appears only in bearings operating inside, such as in a rotary pump, where the bearings are submerged in the liquid pumped. Ball bearing manufacturers don't like these applications because the loss in a roller or ball bearing then becomes higher than that for a plain sleeve bearing. Moreover, there are many liquids pumped that won't do a ball bearing any good, because they corrode them.

The formulas developed from Dr. Styri's data for loss in ball and roller bearings, in the case of oil-mist lubrication, or a drop or two added per hour, are given below:

For deep groove ball bearings:

$$HP = 1.903 \times 10^{-4}\, N(4.40 \times 10^{-3}F^{\frac{1}{3}} + 2.70 \times 10^{-6}W^{1.5}) \quad (8)$$

Double-row self-aligning ball bearings:

$$HP = 1.903 \times 10^{-4}\, N(4.40 \times 10^{-3}F + 1.08 \times 10^{-6}W^{1.5}) \quad (9)$$

Straight roller bearings:

$$HP = 1.903 \times 10^{-4}\, N(4.40 \times 10^{-3}F + 6.18 \times 10^{-6}F^{2/9}W) \quad (10)$$

Spherical roller:

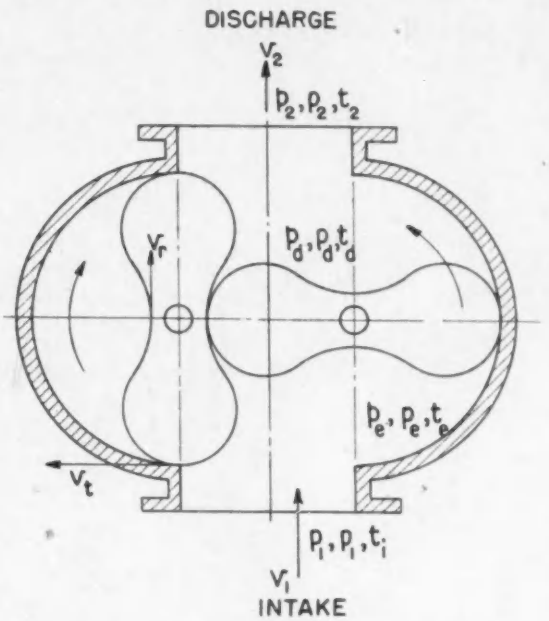


Fig. 1 – Intake loss of the Roots type blower is the centrifugal force less half the entry velocity head

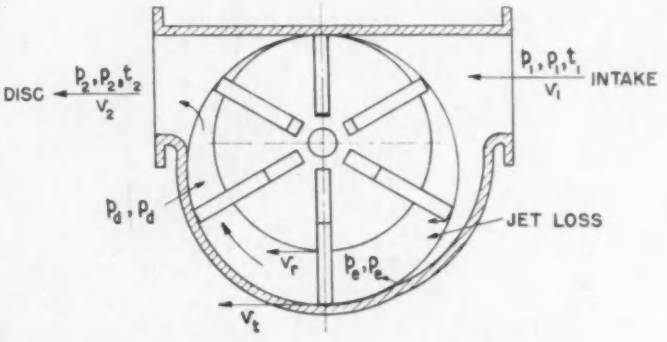


Fig. 2 – Centrifugal force at the end of the suction arc influences intake loss in vane blowers

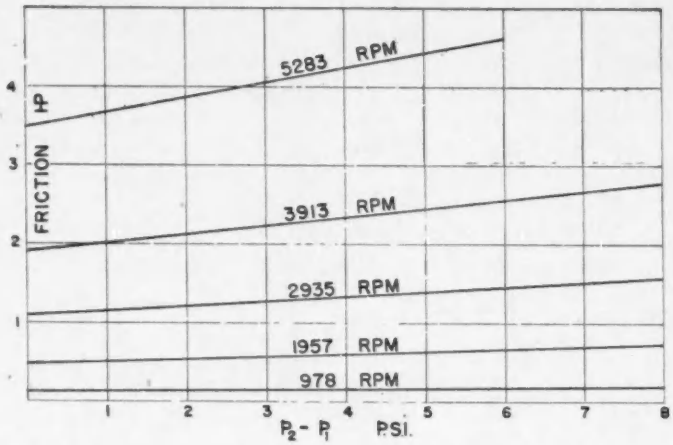


Fig. 3 – Mechanical loses versus pressure difference is shown for a Roots blower tested to check the application of loss analysis

$$HP = 1.903 \times 10^{-4} N(5.86 \times 10^{-3} F + 3.05 \times 10^{-5} F^{2/3} W) \quad (11)$$

Mist spray, or controlled drop-feed, may be found in large superchargers but the much commoner case is that of dip-supply in a sump. For the case of oil-level standing up to the center of the lowest ball or roller, the formulas are

Deep groove ball:

$$HP = 1.903 \times 10^{-4} N(2.50 \times 10^{-6} \mu_s N^{0.67} F + 2.70 \times 10^{-6} W^{1.5}) \quad (12)$$

Double-row self-aligning ball:

$$HP = 1.903 \times 10^{-4} N(2.50 \times 10^{-6} \mu_s N^{0.67} F + 1.06 \times 10^{-6} W^{1.5}) \quad (13)$$

Straight roller:

$$HP = 1.903 \times 10^{-4} N(2.50 \times 10^{-6} \mu_s N^{0.67} F + 6.17 \times 10^{-6} F^{2/3} W) \quad (14)$$

Spherical roller:

$$HP = 1.903 \times 10^{-4} N(3.33 \times 10^{-6} \mu_s N^{0.67} F + 3.05 \times 10^{-5} F^{2/3} W) \quad (15)$$

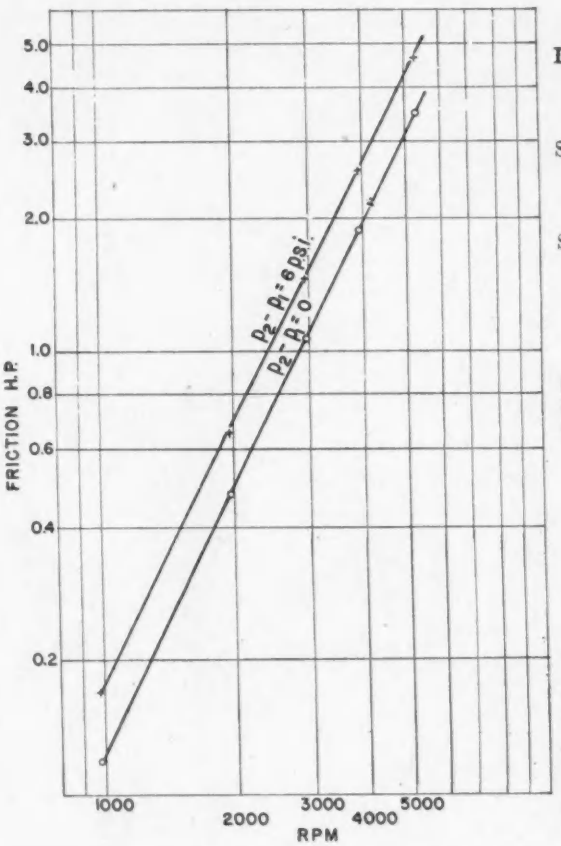


Fig. 4 – Mechanical losses versus speed in tests of a Roots blower

where:

N = rpm

μ_s = viscosity of oil in sump at operating temperature, centipoises

F = size factor

$$= \frac{(I.D. + O.D.)^2}{2} \times W;$$ Bore, O.D. and width in inches.

W = equivalent total load, lb.

Oil from the sump or any other source rises in temperature in the bearing due to the losses, reducing viscosity. We could measure this temperature in laboratory equipment, but for practical application the inlet temperature, that in the oil sump for example, is handier. In formulas 12-15 it is seen that for this value of viscosity, the decrease in viscosity due to heating in the bearing is indicated by the exponent of N, in the viscous loss term, which now becomes less than 1.

Timing and step-up gears are the most troublesome items because real test information on the losses of gears is lacking. All the hand books give us efficiencies of 97 to 98% for unknown load, size, speed, and lubricating method; but tests of automotive transmissions show values as low as 92%. It is evident from a qualitative examination that gear loss

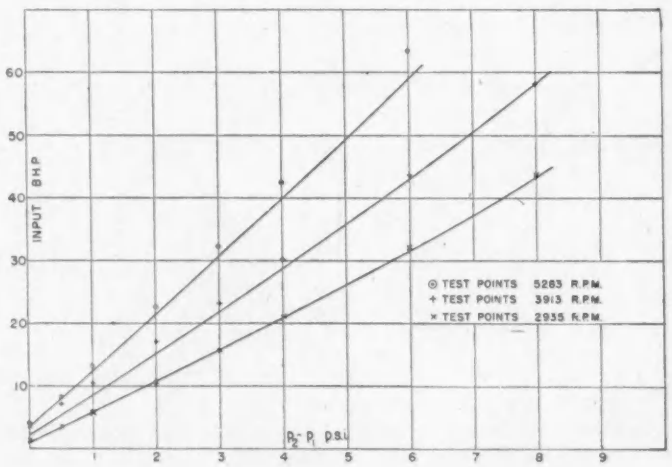


Fig. 5 – Calculated input horsepower versus pressure difference, solid lines, compare fairly well with the test points, particularly at the lower speeds

is similar to sleeve bearing loss. That is, there should be a loss corresponding to liquid shear loss in a bearing which will vary as viscosity, square of speed, and area of contact (size of gear); then there should be a loss of smaller amount proportional to load.

Because of this lack of data it was necessary to make a bald estimate. The assumption taken, mainly based on the automotive transmission tests, was 4½% of maximum horsepower on each pair of gears, viscous shear fraction 70% of the total, and varying with square of speed. It is to be remembered that changing the viscosity of the lubricant or the depth of dip might double or halve this assumption – but the fact remains that we have not enough test material to do anything more nearly rational.

Until some real gear loss tests are available, we shall remain with empirics.

Most superchargers are equipped with some kind of seal at the shafts. There do not appear to be any test data on friction of soft packing or the later types of spring loaded seals. About the only way is to estimate the spring or other unit load on the packing, rubbing area, and apply a friction coefficient. As the loss is always rather small compared to other losses in the supercharger, our limited knowledge is not particularly troublesome.

Coming now to slip, the other of the two factors determining the volumetric efficiency, physicists have failed so far to do a job on leakage in capillary type seals. Formulas for orifices and nozzles neglect the rational computation of friction effects altogether, merely applying a so-called efficiency to the velocity term. On the other hand, pipe flow formulas cover only the friction effects and neglect all velocity effects.

In the supercharger, we may find capillary seals all the way from "line contact" between curved teeth or lobes (practically a venturi tube in character) to long passages such as the sides of a drum-impeller (vane type) or the end faces of a gear or Roots lobe. The first type will be mostly a function of velocity, the second of skin friction.

The formulation of slip based on exponential flow in the turbulent region has been worked out by J. M. Cunningham, as follows:

$$Q_s = 4082\, wb\, \frac{p_d}{p_1} \sqrt{\frac{p_d^2 - p_s^2}{\rho_d p_d \left(2 \log_e \frac{p_d}{p_s} + \frac{fl}{2b}\right)}} \qquad (16)$$

where:

p_d = pressure in discharge side of impeller, psi
p_s = pressure in inlet side of impeller, psi
ρ_d = density in discharge side of impeller, lb per cu ft
f = friction factor, for practically all cases, a constant = 0.054
l = mean length of capillary seal, ft
b = clearance, or depth of capillary seal, ft
w = mean width of capillary seal, ft
Q_s = real slip, at intake flange conditions p_1, t_1, cfm

To get the correct value of b, the clearance, it is generally desirable to give some consideration to any factors that may change the clearance, due either to temperature difference or to speed of rotation. Obviously the temperature of the impeller goes up with pressure difference since the discharge temperature t_2 increases. The housing also will rise in temperature, probably not so much since it is generally subject to external cooling by radiation and convection.

For such a construction as aluminum impeller and cast iron housing there will obviously be differential expansion and the clearances will be altered. If the impeller is subject to appreciable stretch from centrifugal force, clearance may be reduced with increase of speed.

A third cause of change may be distortion of the housing under pressure and temperature change. These possible effects must either be estimated or measured. It is quite possible to make probe measurements of clearance change while running, although so far we have not seen any published data. In many cases the correction for clearance change is likely to be small enough to neglect.

To illustrate the application of the loss analysis for predicting the performance of a supercharger, a Roots blower tested by NACA has been used as an example. This blower had two lobe impellers with a 9⅝-in. O.D., 2 3/32-in. root diameter, 5 29/32-in. shaft centers, 8¼-in. face width, aluminum impellers, cast iron case; an integral 1.5:1 step-up gear drive and timing gears, seven deep groove ball bearings; radial clearance 0.010 in., and clearance 0.015 in., cold. Displacement is 0.382 cu ft per revolution.

Fig. 3 shows the variation of all mechanical losses versus pressure difference. The variation is almost exactly first power. Fig. 4 shows mechani-

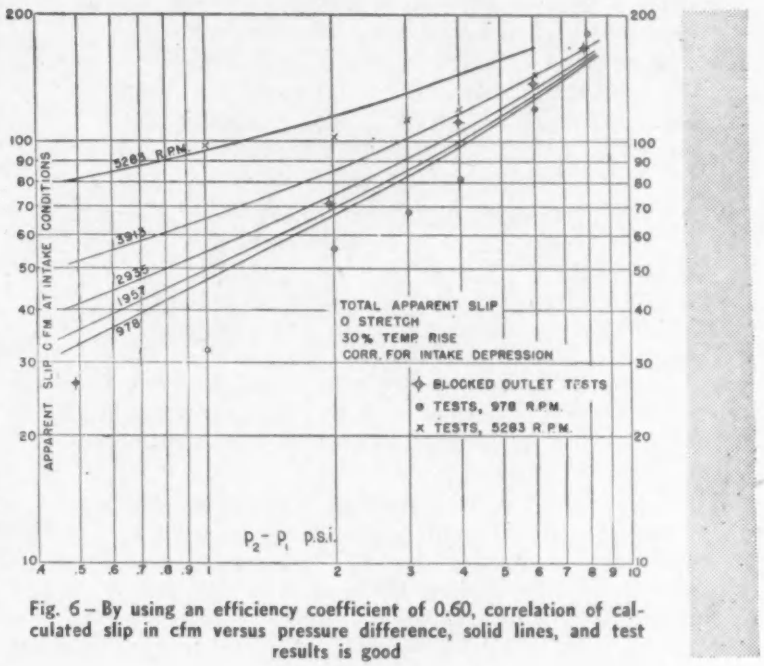


Fig. 6 – By using an efficiency coefficient of 0.60, correlation of calculated slip in cfm versus pressure difference, solid lines, and test results is good

cal losses against speed, and the 2nd power variation is perfectly clear.

Shown in Fig. 5 is input horsepower versus pressure difference. Solid lines are the calculated values; test points are all taken from the line through 15 test points for each speed. It is known that there was some rubbing at 5283 rpm, and there may have been a little at 3913 rpm for the higher pressures. This condition cannot be corrected out by calculation. The rubbing was bad enough so tests could not be continued above 6 psi for the highest speed.

At lower speeds agreement was astonishingly good.

Correlation of calculated slip with test slip was something of a headache. In the first place, the investigators used a coefficient of 0.61 for the sharp-edged orifice used for measuring delivery. It is known from the extensive work of the ASME Fluid Meters Committee that this value is at least a percent too high. The proof is that at low pressure difference the measured test delivery is higher than the displacement, which is impossible.

To get rid of this palpable error that prevents correlation, the writer recalculated all delivery on a coefficient of 0.60. Correlation for the lowest and highest speed, Fig. 6, is quite good. But while all the other speeds correlated fairly well from about 4 to 8 psi, the low pressure results wander around and cross each other. This is mainly due to insufficiently accurate test procedure.

Using curves for apparent slip (true slip plus intake pressure loss effect) is the only way the calculated results can be compared with test values. Intake loss effect for 978 rpm is so small that the line for apparent slip is indistinguishable from the true slip line, which allows another correlation to be applied.

Tests for slip also were made running with supercharger outlet closed, rotating the supercharger just fast enough to hold the required pressure difference. Rotating speed did not exceed 650 rpm for 8 psi differential. It will be noted that the blocked tests give in general higher slip than the running tests. The spread is about 25 to 30 cfm, which would represent about 1% variation in volumetric efficiency at the lowest speed, and less than 1.5% at the highest.

One fact is plainly evident – supercharger testing must be done much more accurately than hitherto. It is obvious from the study of the tests on the Roots blower that the delivery measurements were off at least 1% at high delivery and pressure, and more at the low end. The electric dynamometer shows inconsistencies up to 1.5 hp.

It seems clear that the cooling blast from the motor, which can introduce errors up to several percent, was not corrected out. This error coming from the motor cooling-air blast does not seem to be generally recognized.

Another quite common source of error is the multiple-lever knife edge system usually supplied. We usually take these levers off and substitute a single lever arm with fulcrum plate or tape attachment direct to a weight-type dial scale.

By isolating the losses one by one, this method of analysis can point out *where* an improvement had best be made. For example, the slip on a P.L. supercharger model was increasing noticeably with speed and seemed high anyway. We started improving the seals, quite without effect. Analysis showed that real slip (seals) was not the trouble at all; it was high intake loss.

■

DYNAMOMETER TESTS

cont. from p. 46

paper of each unit. Fig. 3 shows the recording devices on the dynamometer.

Other phase of the test operation is the determination of machine losses from cylinder, rack, and shoe. These three losses are found in two batches; cylinder and rack losses make up the batch of material collected from over the rack. Shoe loss collects separately over the shoe.

Rough samples of grain lost in these three units can be described as follows:

1. Grain not removed from the head by the cylinder – held fast by the glumes and stem still attached to the straw – is considered shelling or cylinder losses;

2. Loose grain not removed from the straw in passing over the rack is considered as separation or rack losses;

3. Grain lost over the sieves comprises the shoe loss.

This material must be processed to separate and weigh the losses. Passing it through a cylinder-rack separator shakes out the loose grain (rack losses). Straw holding unthreshed grain is automatically threshed out and separated, as in Fig. 4. This is the cylinder loss. Since shoe losses accumulate at an isolated location, they can be easily collected and weighed.

Still greater use of the dynamometer is anticipated. It has been redesigned with a separate engine for power-take-off operation, using the tractor for drawbar power only. This arrangement should give greater flexibility in test work as well as closer control of both power-take-off speed and rate of travel for drawbar work.

January Check List of SAE Meetings Papers

The following papers, divided into four general categories, presented before National and Section Meetings of the Society of Automotive Engineers, Inc., are now available in mimeographed form to SAE Members for 25¢ each and to Non-Members for 50¢ each.

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NEW PAPERS

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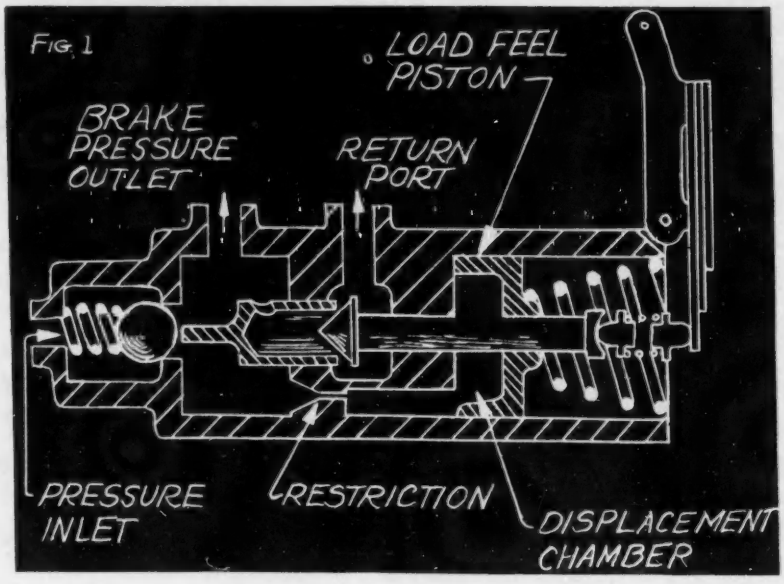
BRAKE VALVES



New Concepts Advance Safer Plane Braking

Digest of paper

By E. F. LOWEKE

Hayes Industries, Inc.

CONVENTIONAL principles governing power brake valve design are inadequate for efficient and safe braking of large modern aircraft, declares Loweke. Only by providing for the variable nature of flow through the brake system and valve can desirable results be achieved. In discussing recent valve design improvements, he demonstrates that:

When the pilot of present-day air transports applies the brakes, he expects the same response to which he is accustomed in operating the brakes of his automobile. Wartime development has made progress in smooth, rapid braking – minimum time lag between depression of the foot pedal and the sensation of braking at the wheel.

Quick braking accomplished by delayed load feel is reflected in the Dynaflo power brake valve. (Delayed load feel speeds the fluid to the brake, hastening braking action. As shown in Fig. 1, delayed load feel with non-compressible fluids is obtained by providing a displacement chamber backed up by the load feel piston. This chamber is in restrictive communication with the valve brake chamber through a restriction or choke.

Upon opening the inlet valve, sufficient pressure is developed in the brake chamber to impart a high initial accelerating force to the fluid. The pressure overcomes the fluid's high-velocity head loss and surges through the tube lines to the brake.

Pressure is not yet imposed on the load feel piston; fluid in the brake chamber must pass through the choke to the displacement chamber. When displacement is taken up, the load feel piston abuts the connecting link. It in turn reacts against the spring load to balance the input force regulating the input pressure.

One desirable feature of the choke is that it is easily adjustable to cope with operating variables such as differences in brake displacement and head loss of the brake line. By the same token, this design comes close to the ideal valve – one that fits any aircraft installation.

This same Dynaflo valve incorporates a feature which reflects the belief that an unbalanced valve can be faster than a balanced one. (It is more responsive to pressure since reactive forces are absent.) The refinement, known as Inertia Balance, is shown in Fig. 2.

In the closed position, the valve is unbalanced by a force equal to the fluid pressure acting against the inlet valve seat area. This unbalanced force is stored in a low-rate spring on a telescoping connecting link during initial movement of the valve operating lever.

The moment the ball is cracked off the seat and flow starts, unbalanced forces are distributed. Energy stored in the spring is released to lift the ball high off the seat.

Another interesting feature in this valve is the refinement of the inlet ball seat. When the valve is open, fluid flows through this seat with a velocity greater than 200 fps. This generates high local temperature in adjacent parts. By controlling mass relationship between the ball and seat so that the seat will expand away from the ball, as shown in Fig. 3, the valve opening will increase.

The pin for lifting the ball is proportionately slenderized. Proper expansion of these parts automatically increases the valve opening.

These features demonstrate that valve performance can be improved by coupling design ingenuity with a careful study of mechanical details. (Paper "Power Brake Valves," presented at the Southern California section, Nov. 1, 1945.)

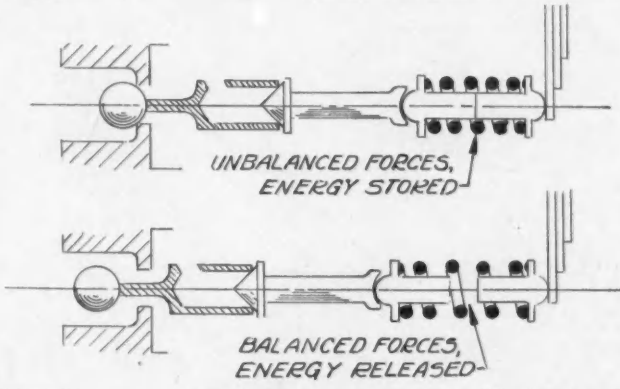


Fig. 2 (left) – By the Inertia Balance feature, stored energy of a low-rate spring is released to increase the valve opening of Dynaflo brake valve

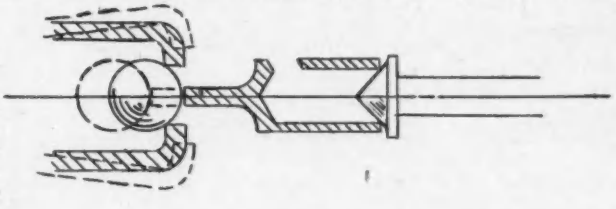


Fig. 3 (right) – The tendency of parts to heat and restrict the valve opening is overcome by controlling the relative mass of parts to increase the opening under thermal expansion

TEMPERATURE COMPENSATION

Mechanized Farming Is Redesigning Tractors

Digest of paper

By K. W. ANDERSON

Deere & Co.

TREND toward greater utilization of labor-saving farm implements requires a re-engineering of tractors, Anderson declares. Large volume sales of integral implements in recent years indicate that the farmer finds mechanization to his liking and will not return to hand labor. Anderson shows that:

Tractor engineers must take cognizance of implement requirements in tractor design.

Influence of these new machines is demonstrated by the front-end loader. It does more than the name implies. Not only is the loader useful as a hoist around the farm, but it justifies its existence by completely mechanizing the disagreeable manure-loading job formerly performed by the spreader. Yet the price of a loader ranges from only $175 to $300.

Potential market for the front-end loader is sizable. Assuming that it looms as a spreader replacement, these Bureau of Agricultural Economics statistics are pertinent: spreader population in this country in 1945 was 1,330,000 as against a tractor population of over 2,000,000. Accelerated activity among loader manufacturers bears witness to its increasing popularity.

But unless the tractor is built to take this implement, the loader will tax the tractor beyond capacity. Extra weight of the loader imposes a severe burden on wheels, rims, spindles, bearings, steering, and frame. Tractor engineers must give attention to these items:

1. Front tires with greater capacity;
2. Greater load-carrying capacity on all of the parts mentioned above;
3. Constant source power for lift;
4. Easier steering and gear shifting, and
5. Facilities for easy attachment.

Other Implements

Another implement entering the farming picture is the combination loader-stacker. This unit is a large sweep rake that elevates hay onto a wagon or stack. It has demonstrated great savings in labor and operating costs and promises to replace the stationary stacker.

Influence of the loader-stacker on tractor design is similar to that of the front-end loader, except that the stability factor is accentuated. And tractor redesign in this case can be worthwhile considering the additional tractor sales this implement may result in.

Integral-power post-hole diggers make another difficult farm chore easy. One digger has a capacity of 500 holes per day – 10 times the output of the average man. And $300 or less will buy one. Certainly this machine is attractive to any farmer, regardless of what he grows.

To these implements can be added a growing list of others that are making the lot of the farmer more pleasant. Included are dirt scoops, tractor wood saws, cotton pickers, precision planters for sugar beet cultivation, dusters, and sprayers.

To accommodate these devices, all-purpose tractors will have to incorporate such general features as hydraulic control eliminating hand levers, ease of attachment, and a basic means of attaching implements without interfering with other tractor uses such as propelling drawn implements. (Paper "Current Influences of Integral Equipment in the Tractor Industry," presented at the SAE National Tractor Meeting, Sept. 11, 1946.)

Longer Life for Piston Rings Predicted with Chrome Plating

Digest of paper

By J. B. MINNICH

Wright Aeronautical Corp.

CHROME plating the piston-ring periphery will increase ring life and decrease ring troubles, says Minnich. From thousands of hours of laboratory tests he finds that:

Installation of a chrome-plated compression ring in the top groove nearly doubles the life of the rest of the rings on the piston. If all the rings are plated, their durability is quadrupled.

During scuffing, material removed from one ring adheres to the cylinder and damages the other rings on the piston. Chrome plate has a distinct advantage over cast iron in this respect. Its low rate of wear decreases the tendency to load the cylinder.

Cast-iron rings acquire feathered edges after slight scuffing or heavy wear that increases oil consumption and rate of wear of all rings in that cylinder. But chrome-plated rings will not feather until the chrome is worn through.

Oil consumption is also affected by the amount of face taper of the chrome-plated top ring. Experiencing manufacturing difficulties with a ¾-deg taper, Wright Aeronautical increased the angle to 1½ deg. But a

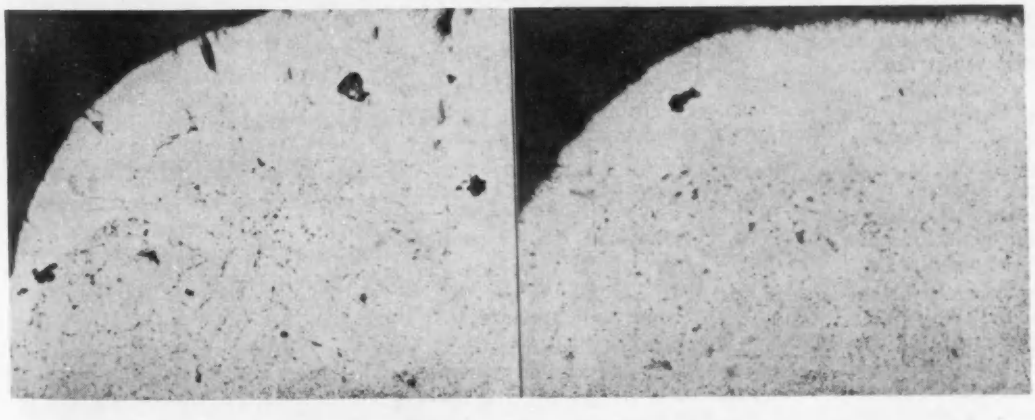


Fig. 1 – Forming a radius on the piston-ring corner before plating the chrome (photograph at left) results in lower oil consumption than rounding the corner after plating (photograph at right)

30% increase in oil consumption accompanied the change. So back they went to the ¾-deg taper.

Another item critical to oil consumption is the method of forming outside diameter corners. Some corners were formed by providing sharp corners before plating and then stoning the corner after plating. Another technique used was to form a radius before plating, allowing the chrome to plate around the arc. Fig. 1 shows the two types.

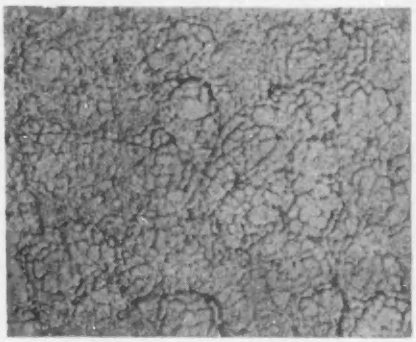


Fig. 2 – This is what the surface of chrome plating looks like when magnified 500 diameters. The photomicrograph above is hard chrome, and the one at right is porous chrome

When these two types were tested, engines using rings with radii formed before plating consumed 10 to 15% less oil.

Chrome plate carries with it some disadvantages. It lowers fatigue strength of steel rings by 13%. Breakage in engines correlates with these test results. But this is not too serious. Chrome-plated rings rarely broke, and then only under severe test conditions.

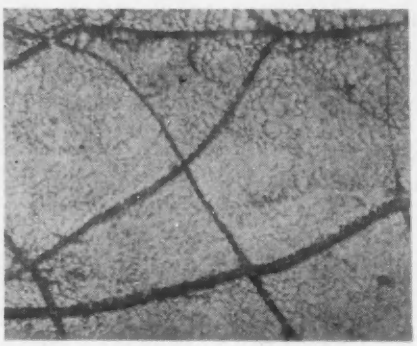
Just what kind of chrome to use also posed a problem. Many techniques using both hard and porous chrome were tried. Single-cylinder and full-scale engine tests conducted under varying operating conditions revealed no significant differences in rate of ring wear or general ring durability with the two types of plating. Fig. 2 shows how they appear when magnified.

During discussion of Minnich's paper, D. M. Smith, McQuay-Morris Mfg. Co., added the thought that taper-face hard chrome rings and straight-face porous rings will work equally well only if all conditions are held to proper specification.

But the greater the porosity of the chrome, the quicker the ring itself will wear and the more severe will be the wear on the cylinder wall and lower rings. He said that there should be only enough porosity to cause the ring to seat. Any additional will result in undue wear to other engine parts; insufficient porosity will slow up ring seating and allow excessive oil consumption.

Causes Ring Wear on Side Face

While chrome plate demonstrates good wear characteristics when applied to the ring periphery, it is detrimental on the side face. Several rings were chrome flashed on the side faces and I.D. as a corrosion preventive in handling and storage. Tests showed that these rings severely wore the piston groove faces in several hours.



Another mistake that should be avoided is running chrome-plated rings on chrome-plated cylinders. Operating this combination will remove chrome from the ring and barrel in a few minutes. It can cause considerable engine damage. (Paper "Development of Chrome Plated Piston Rings for Aircraft Engines," presented at the SAE National Aeronautic Meeting, Oct. 4, 1946.)

Road Service Points To Better "Autoshift"

Digest of paper

By O. H. BANKER

New Products Corp.

TAKING a cue from past experience will insure future success of automatic transmissions, says Banker. He points out that:

Outstanding factors in the operation of automatic transmission-equipped buses that influenced design changes are:

1. Driver carelessness;
2. Improper adjustments,
3. Parking difficulties.

Abuse by drivers during warm-up and parking constituted the most prevalent source of troubles in the use of automatic transmissions. Since there is no foot clutch and since the clutch, planetary gears, and carriers make up a considerable revolving mass, forcing the forward and reverse lever into engagement while these units are in motion is disastrous.

The driver was supposed to depress the button to the left of his foot before moving the engager lever. By ignoring this, he smashed planetary and reaction gears when shifting to reverse and ruined the reaction clutch when shifting to forward.

This was overcome by an interlock that holds the shift lever in neutral position so that it cannot be moved until the button is pressed. Stopping the revolving mass frees the engager lever to move in either direction.

Adjustments Important

Second lesson learned from experience is that proper adjustments must be made to prevent major failures. This is particularly true of the engine idle adjustment and adjustment of the engine clutch and at one time the air brake release.

When the engine died in traffic, the driver would throw all caution to the winds, racing his engine and jamming it in gear while trying to get out of the way. This upped maintenance of the automatic transmission and sometimes twisted the axle. When the engine clutch is out of adjustment, the engine starts with a jerk. Jerky starts caused by improper brake release also were blamed on the automatic transmission in the early days.

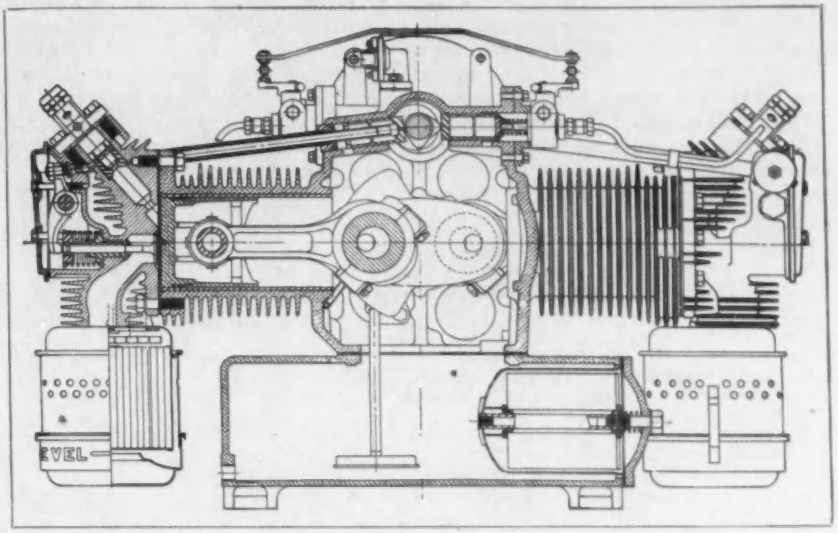
Carelessness reared its costly head in parking too. Cases are known where parked buses left in gear resulted in collision and damage. Installation of the interlock on the engager lever eliminated this hazard. The engine cannot be started until the shift lever is in neutral.

Other improvements made include better clutch shoes. Original stamped and brazed shoes broke at the weld. By using cast manganese shoes, this trouble was eliminated and the cost was reduced to one-fifth that of the original shoe.

Clutch linings also were improved. Average lining life is now 20,000 miles as compared to 3500 miles of the older type.

Only by greater use will the need for refinements be discovered and achieved to afford all automotive vehicles the safety and comfort inherent in automotive transmissions. (Paper entitled "Ten Years' Experience with Automotive Transmissions in the Bus Field," presented at the SAE National West Coast Transportation & Maintenance Meeting, Aug. 22, 1946.)

DIESELS



Broadened Markets Greet a Smaller Engine

Aircooled Diesel

Digest of paper

By J. C. HOIBY

D. W. Onan & Sons

OPERATING economies shown by small diesels ranging up to 15 hp warrant their competing with gasoline engines for continuous-type-of-service applications such as electric generating sets, claims Hoiby. Discussing possibilities of a recently developed aircooled diesel of this type, he shows that:

Advantages of the low horsepower diesel over the gasoline engine stem from:

1. Reduced maintenance.
2. Greater fuel economy.
3. Reduced insurance rates.

Diesel engines will run at least twice the number of hours before requiring valve and combustion chamber maintenance. Small gasoline engines at constant speed suffer from heavy lead and carbon deposits in the combustion chamber. Higher exhaust-valve temperature and passage of solid leads through the exhaust port of a gasoline engine make for more frequent valve maintenance. Spark plugs and breaker points require servicing two to four times as often as diesel injectors.

As regards fuel costs, savings realized in this area alone will pay for the difference in cost between a diesel and gasoline engine within one year. For the sake of comparison, let us assume 2000 hr of operation per year with the prices of fuel oil and gasoline at 9¢ and 15¢ per gal, respectively. Fuel costs of a diesel-powered generating set with a 5 kw output will run $131 for the year, whereas a gasoline engine on this generator will burn $375 worth of gasoline under similar conditions. In foreign countries this saving will be much greater because of the wider spread between oil and fuel oil gasoline prices.

Because of the hazard gasoline presents, property insurance rates usually are high.

To meet market requirements of a stationary engine in this field, a 2-cyl. diesel delivering 12 hp at 1800 rpm has been developed. The engine is an aircooled, opposed-piston type with a 3½-in. bore and 3½-in. stroke. Shown in Fig. 1 is a cross-section of the engine.

Light weight is inherent with its construction because of short length camshaft, crankshaft, and crankcase and because all major parts are aluminum. The engine weighs 220 lb and measures 18¾ in. high x 29¼ in. wide x 24 in. long.

An electric starter direct-connected to the crankshaft performs the dual function of (1) a motor for starting the engine and (2) a generator for recharging the battery. Surrounding the generator is a rotating axial flow fan for cooling the cylinders.

Although cylinder and head temperatures are higher than those encountered with water-cooled engines, they are within a satisfactory range of operation. Effective finning and excellent heat conductivity of the aluminum cylinders keep fuel from cracking before injection and prevent piston rings sticking.

We can look to the future for greater use of aircooled diesels up to 30 hp because of their low cost, lighter weight, and simplicity of manufacture. (Paper entitled "Development of the Aircooled Diesel Engine" presented at the SAE National Tractor Meeting, Sept. 12, 1946.)

Low Horsepower Diesel

Digest of paper

By L. A. GILMER

The Oliver Corp.

BY lowering initial cost of diesel engines in the 20 to 40 hp class, manufacturers can give the farmer an efficient powerplant in areas where use of gasoline is prohibitive, reports Gilmer. He establishes a pattern for the diesel engine industry to follow by showing that:

In many sections of the country farmers are discontented with gasoline engine tractors because of unrefunded high gasoline taxes or because of the inavailability of gasoline. Diesel engines more than satisfy performance and operating requirements of these tractors. Only drawback to the use of diesels is that they cost so much more than gasoline engines.

But because of the greater fuel economy possible with diesel engines, a higher initial price for them is justified. Certainly prices of diesels currently three to four times those of gasoline engines are entirely out of line. How much the price differential between a diesel and gasoline engine should be to make use of diesels economically feasible to farmers can be determined from a study of performance and fuel consumption data.

Table 1 shows the difference in fuel consumption between these two types of engines at different loads. Tests indicate that the average operating load is 60% of full load. At this point diesel engine fuel is 70% that of the gasoline engine.

Converting this to a cost ratio is complicated by varying fuel prices in different areas and varying tax-refund

policies. But assuming that the ratio of diesel fuel to gasoline price is 0.4 to 0.6 and multiplying these factors by the 0.7 consumption ratio, the operating cost ratio varies between 0.28 and 0.42. At gasoline prices ranging from 12¢ to 18¢ per gal, and a gasoline consumption of 0.115 gal per bhp per hr, a cost saving of 0.8¢ to 1.5¢ is obtained.

From this analysis it appears that if the tractor cost difference to the farmer is kept between $400 to $500, diesels in sizes over 30 hp would be justified in all territories including typical gasoline sections. For sizes under 30 hp, a diesel will pay for itself only in so-called heavy fuel areas.

By eliminating design refinements, increasing production volume, and producing cheaper injection equipment, diesel engine builders can bring the cost of diesels below the $400 to $500 justifiable differential. (Paper entitled "Diesel Engine Requirements for Farm Tractors," presented at the SAE National Tractor Meeting, Sept. 12, 1946.)

Table 1 – Comparison of Diesel and Gasoline Engine Fuel Consumption Rates

	Spec. Fuel lb/bhp/hr	Fuel Consumption in Gal per Hr		
		20 hp Engine	30 hp Engine	40 hp Engine
Full Gasoline	.55	1.78	2.68	3.58
Load Diesel	.48	1.37	2.05	2.74
Difference		.41	.63	.84
¾ Gasoline	.65	1.58	2.38	3.17
Load Diesel	.50	1.07	1.61	2.14
Difference		.51	.77	1.03
½ Gasoline	.80	1.30	1.95	2.60
Load Diesel	.58	.83	1.24	1.66
Difference		.47	.71	.94

Since the average tractor life is about 5000 hr, the initial cost difference should be offset in 2500 hr to provide any appreciable savings to the farmer. In this time the total fuel cost saving with the diesel engine amounts to:

a. $240 to $450 for the 20 hp engine;
b. $360 to $665 for the 30 hp engine;
c. $480 to $900 for the 40 hp engine;

Standard Rubbers Aid Users and Producers

Digest of paper

By G. H. SWART

The General Tire & Rubber Co.

MEANINGFUL classification of rubber compositions enable the user to select the most suitable and economical rubber for his product and simplify problems of the rubber supplier, relates Swart. In reporting on the joint SAE-ASTM committee's work in this field, he goes on to show that:

Before rubber classification, automotive manufacturers specified slightly different stocks for almost identical service. Minor property differences in each specification made it impossible for the rubber producer to use the same stock for more than one customer. In other cases the rubber technologist was hampered in providing the best product because the buyer's specification was not suitable.

These conditions boosted unnecessarily the costs to both producer and user.

To bring about some semblance of efficiency, painstaking study was made of over 500 buyer specifications representing many rubber consumers including the automotive industry. Classification was based on those physical properties that appeared most frequently in these specifications.

Hardness and tensile strength of each rubber is the result of tabulated commercial frequency. Enough classes under each hardness are listed to provide the user with a complete range; but the divisions are held down to a minimum for simplicity.

To simplify rubber selection for special application such as fan belts, oil seals, and gaskets, the tables were extended to include special properties.

Although the classification job is far from completed since behavior of natural and synthetic rubber is in many respects yet a mystery, users and suppliers find the SAE-ASTM specifications expeditious and economical. The challenge is still before the rubber technologist to determine fundamental physical properties as well as to understand complex properties such as tear, abrasion, weathering resistance, electrical conductivity, and high-temperature aging.

With continually increasing usage of rubber and cooperation of all groups interested in the material, secrets of its behavior will be uncovered. (Paper entitled "Classification of Rubber and Rubber Compounds," presented at the SAE Summer Meeting, June 4, 1946.)

Bus Quality Earns More than It Costs

Digest of paper

By H. E. SIMI

Kenworth Motor Truck Corp.

SKIMPING on bus construction is a penny-wise and pound-foolish policy, contends Simi. Quality nets operating economy for the bus operator and greater profits for the manufacturer. He advises that:

Prewar bus designs in which material costs were cut to the bone and deviations meant extra charges were based on false economy. The extra features raised the initial cost to the customer and reduced the builder's profit because of the special handling required for nonstandard equipment.

Manufacturers were not entirely to blame since vehicles too often were bought on price rather than quality.

But time has changed these methods. Improved operating and maintenance efficiency has demonstrated to the operator the value of quality in increasing net earnings of the vehicle. Strides in manufacturing practices made during the war plus the urgent need for better equipment makes this a propitious time for the industry to turn over a new leaf, reversing the downward quality trend.

First step toward this objective involves the basic design. It must be arranged so that steps of assembly are simple and orderly. Next step in reducing manufacturing costs is adoption of machine methods. They are fast, accurate, uniform, and controllable. Machine methods produce higher quality at lower cost; manual methods produce questionable quality at higher cost.

Another very important means of achieving both quality and economy is the use of standardized components. Standard equipment made by parts manufacturers is much more completely tooled – both for fabrication and quality control – than equipment that is special.

Rarely can a vehicle manufacturer afford complete tooling of special components; quality usually suffers. Standard units have the important advantage of quantity production. They are most readily available to the vehicle builder and to the operator for replacement at a nominal price.

But quality is of no avail if the bus designer does not fulfill his obligation. He must satisfy both the operator's quest for an economical-to-operate-and-maintain bus and the passenger's demand for travelling comfort. (Paper "Design Features of Modern Buses" presented at the SAE Southern California Section, Feb. 8, 1946.)

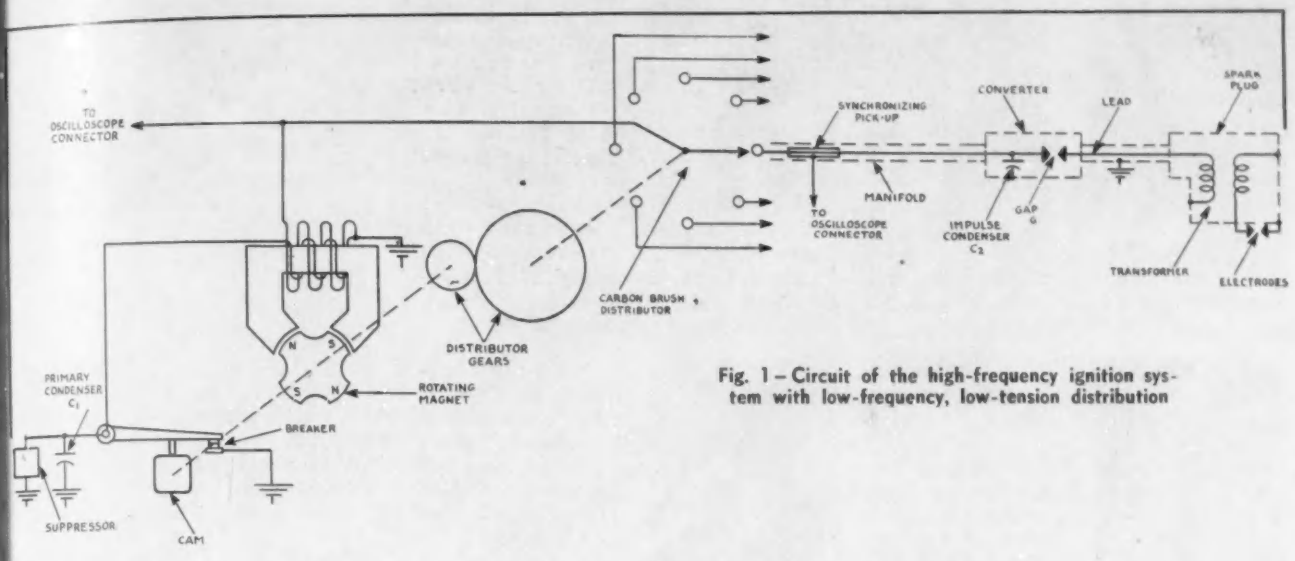


Fig. 1 – Circuit of the high-frequency ignition system with low-frequency, low-tension distribution

Low-Tension System Cures Ignition Ills

Digest of Paper

By A. C. WALL

P. R. Mallory & Co.

AIRLINE operators now can look forward to relief from high-tension ignition troubles with a newly developed high-frequency low-tension system, Wall advises. He points out that:

Both laboratory and flight tests with this type of low-frequency distribution show absence of the usual ignition difficulties.

For one, this system extends spark-plug life. It produces an average plug erosion rate of about 0.001 in. every 50 hr. If the ignition system can fire the spark plug as it erodes from 0.014 to 0.024 in., life of the plug would be 500 hr. Flight tests bear out this estimate in that regapping is necessary at the 500-hr inspection. This is a considerable improvement over conventional systems.

Although no reliable tests exist that demonstrate the ability of this system to resist spark-plug fouling, it has been shown to operate satisfactorily under conditions where fouling prevented operation of conventional engines. Even deliberate attempts to foul out the high frequency system did not impair its operation.

Such tests as idling with special rich carburetor settings for periods as long as 5 hr were tried. At the end of the idling period, the engine responded immediately to wide open throttle and pulled rated power in a normal manner. Addition of kerosene and lubricating oil to the carburetor also failed to foul the plugs.

Apparently altitude has no effect on the system either. In tests at 38,000 ft, the low-tension ignition system installed in standard B-24's showed no malfunctioning or deterioration.

With this system, pilots no longer will be plagued with radio interference associated with high-tension ignition. Since all high-frequency currents in the ignition system are properly confined to a localized concentric system near the spark plug and, since sparking in the distributor is reduced by a suppresser circuit and contact-making distributor, this type of ignition is inherently quiet.

Shielded joints had to be maintained extremely tight on high tension systems to avoid noise. With high-frequency low-tension ignition, radio noise is suppressed as long as metallic contact is maintained at one point—even though the connector nut may be loose.

Circuit of this ignition system is shown in Fig. 1. A standard aircraft magneto is used, modified by inclusion of a carbon brush distributor in place of a jump-gap type and alteration of the coil for production of low-tension instead of high-tension voltage.

Operation of the magneto is identical to that of a high-frequency magneto except for the magnitude of secondary voltage produced. Current is distributed to individual spark-plug wires through an ignition shielding manifold exactly as with high tension. Connected to the manifold ring—where spark-plug leads normally are attached—is a converter, shown in Fig. 2.

A hermetically sealed connector conducts low-tension current from the magneto to the converter condenser, at the same time eliminating the effects of altitude and moisture. Housed in the conventional high-tension spark-plug shield is the high-frequency transmission line connecting the converter to the spark plug.

Externally the spark plug is identical to its high-tension counterpart. Within the plug barrel is a small transformer that increases the original 1200-v signal from the magneto to create a spark at the plug electrodes.

Two other unusual features are included in this system.

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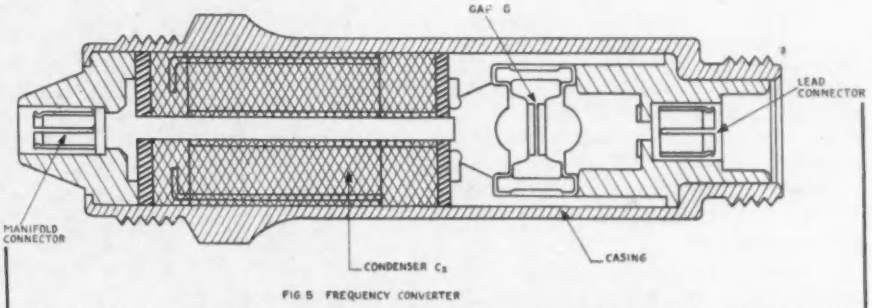

FIG 5 FREQUENCY CONVERTER

Fig. 2 – The converter consists of an aluminum housing containing a special condenser and a self-triggered gap, adjusted to break down at 1200 v

About

B. G. REED, factory manager of Northrop Aircraft, Inc., Hawthorne, Calif., was elected vice-president in charge of manufacture, at a recent meeting of the Board of Directors. He will supervise the output of Northrop's new passenger-cargo aircraft and oversee the company's military contracts.

A. V. SMITH, formerly vice-president of Homelite Corp., Port Chester, N. Y., was appointed general manager of the new Lincoln-Illinois plant now under construction for Lehn & Fink Products Corp., Bloomfield, N. J., manufacturer and wholesaler of drugs, cosmetics, hand creams, etc.

D. FIRTH who was formerly director of engineering for Dodge Mfg. Corp., Mishawaka, Ind., was recently promoted to vice president in charge of engineering. Before joining Dodge, he was connected with the Marvel Carburetor Co., Flint, Mich., having risen to vice-president and general manager.

The appointment of **JOSEPH W. ESKRIDGE** as factory manager of the Hudson Motor Car Co., Detroit, was recently announced. He is a veteran of 20 years with the company and has been in charge of Hudson's car-building program since the resumption of automobile production.

N. J. RAKAS, who is now vice-president and general manager of Fisher Plastics Corp., Newton, Mass., was previously affiliated with Chrysler Corp. He is a graduate from the Michigan State College, and received his Master's Degree in chemical engineering.

PHILIP H. PRETZ, who came to Lincoln-Mercury in charge of the experimental engineering section, Detroit, from the Chrysler Corp., is known for his work in the field of suspension, riding and handling. Prior to joining Chrysler he was employed by Cadillac.

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ROBERT JEROME GLEFFE, a former student at Michigan State College, is a draftsman with Fisher Body Division, General Motors Corp., Detroit.

Serving in the U. S. Army as topographist until recently, **WILSON H. DAVENPORT** has joined Sweden Freezer Co., Seattle, as a draftsman.

ARTHUR J. CLARK, JR., is a stress analyst with the Curtiss Propeller Division, Curtiss-Wright Corp., Caldwell, N. J.

Now service manager with Norbom-Farrell Engineering Co., Philadelphia, **M. GEORGE BROWN** had been mechanical supervisor with Superior Engine Division, National Supply Co., Springfield, Ohio.

JOHN H. CLAREY has joined Vic Pastushin Industries, Inc., Los Angeles, as sales engineer.

Resigning from Engineering & Research Corp., Riverdale, Md., **RALPH F. BROBERG** is now a flight test engineer for Republic Aircraft Corp., Farmingdale, L. I., N. Y.

A graduate of Rensselaer Polytechnic Institute, **PHILIP E. BOND** is a mechanical engineer with Ebasco International Corp., New York, power-plant consulting engineers.

CAPT. SEWARD H. ALLEN has returned to the University of Southern California, Los Angeles, having been discharged from the U. S. Army.

Completing his work at M.I.T., **WILLIAM HENRY HOOPS** is a junior engineer with Fairchild Engine & Airplane Corp., Jamaica, L. I., N. Y.

K. P. FORMAN, formerly in the Washington, D. C., office of War Supplies Procurement, Commonwealth of Australia, has returned to Peakhurst, NSW, Australia.

Prior to joining the University of California, Albuquerque, N. Mex., as engineer, **JACK PERKINS SHOUP** was director of Research Associates, Colorado Springs, Colo.

KENNETH L. MULHOLLAND has joined Sears, Roebuck & Co., Chicago, in the capacity of assistant buyer.

CREIGHTON M. LAWHEAD, having been discharged from military service with the Air Materiel Command, AAF, is a mechanical engineer with the staff quality control group, Corning Glass Works, Corning, N. Y.

Until recently a student at California Institute of Technology, **FRANK H. LAMSON-SCRIBNER** is a mechanical engineer in the Industrial Engineering Division of E. I. duPont de Nemours & Co., Deepwater, N. J.

Promoted from experimental test engineer, **ALAN A. KURTIS** is senior engineer in the Research Division, Wright Aeronautical Corp., Wood-Ridge, N. J.

PAUL R. KOLBE, project engineer with Fredric Flader, Inc., has been loaned to the Fairchild Engine & Airplane Corp., NEPA Division.

Transferred from South Bend, Ind., to Hollywood, Calif., **MAX N. HUBER** is now sales engineer with Bendix West Coast Division, Bendix Aviation Corp.

FRANK S. JONES is with Phelps-Dodge Copper Products Corp., Bayway, N. J.

Until recently a consulting engineer, **ERWIN F. LOWEKE** has been appointed chief engineer for Thorrez & Maes Mfg. Co., Jackson, Mich.

ROBERT HOUSKA is now an estimator-designer for Karp Metal Products, Inc., Brooklyn, N. Y. He had been a design engineer for Fisher Body-Ternstedt Division, General Motors Corp., Detroit.

Resigning from Pratt & Whitney Aircraft Division as a designer, **EDWARD E. KIRKHAM** is a design project engineer for Federal Electric Products Co., Hartford, Conn.

An active member of the Cleveland Section, its former chairman **W. G. PIWONKA** has resigned from the Cleveland Transit System to become technical service manager of the Motor Coach Division, White Motor Co., Cleveland. He is currently vice-chairman for the T & M Activity of the Section.

Members

Resigning as layout draftsman, De-Laval Steam Turbine Co., Trenton, N. J., **AVREL MASON** has become analytical engineer, Fairchild Engine & Aircraft Co., N. E. P. A. Division, Oak Ridge, Tenn.

The Motor Rim & Wheel Service of California announces the return to active duty of **WESLEY D. SMITH**, as co-owner and general manager after an absence of four and one half years in the Naval Service.

JOSEPH SYDNEY HARTLE is now serving the Kieckhefer Container Co., Delair, N. J., in the capacity of designer.

Formerly field engineer of the Cleveland Graphite Bronze Co., **GLENN ROBERT GRAHAM** is now mechanical engineer, materials research department, Kellex Corp., Silver Spring, Md.

Resigning from Thompson Products, Inc., Cleveland, **ROBERT C. SCHUTT** has been appointed vice-president-treasurer of M. S. Equipment, Inc., Cleveland.

Prior to joining United Aircraft Corp., Sikorsky Aircraft Division, Bridgeport, Conn., **LOUIS MYRON PAWLETT** was employed by Lumalett Cooperative Service.

TWO WIN PROMOTIONS

J. J. MIKITA, former associate director of research, Texas Co., has been appointed engineering laboratory director of Du Pont de Nemours & Co., petroleum chemicals division, with headquarters in Wilmington, Del. He will head the engineering research & technical service activities for wide marketing in 1948.

ARTHUR H. KIBIGER, an engineer and stylist of 21 years' experience, has been named director of styling for Willys-Overland Motors, Inc., Toledo. For the past 12 years he had been assistant chief designer for the Hudson Motor Car Co. Until entering the automotive field, he was associated with a number of Indiana architectural firms.

B. F. KLEIN was elected president of the Coast Petroleum Co., Inc., Manasquan, N. J., not only distributors of petroleum products but also marketers of a complete line of home heating equipment. He organized the company to distribute the products of the Valvoline Oil Co. and the Calif. Oil Co. in N. J.

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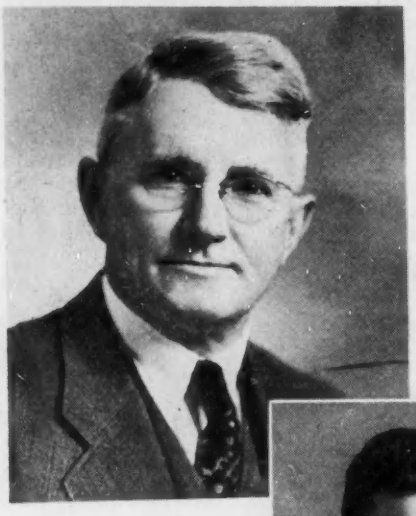
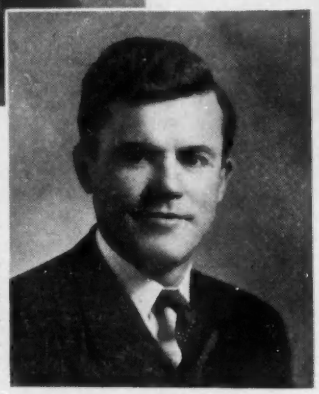
BEN H. ANIBAL (right), who has been in charge of engineering, Pontiac Motor Division, General Motors Corp., since 1925, has been promoted to the newly created position of administrative assistant to the general manager. **GEORGE A. DELANEY** (left), who has been assistant chief engineer for some years, becomes chief engineer succeeding Anibal. He is chairman of the SAE Constitution Committee for 1947, was formerly Membership Committee chairman, and is a past chairman of the Detroit Section.

SAE Fathers and Sons . . .



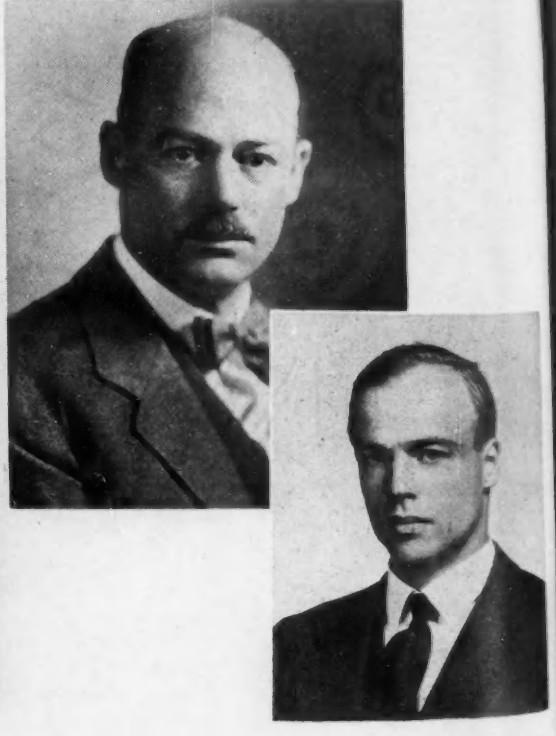


Past-Chairman **ALEXANDER GRAY** (M '32) of the SAE Canadian Section (upper left) who is president of Gray Forgings & Stampings, Ltd., Toronto, and an important Canadian industrialist, with his son, **ALEX L.**, vice-president of the company, who was recently elected to SAE membership.

A past-president of Metropolitan Section, **SYDNEY G. TILDEN,** president of S. G. Tilden, Inc., and Permafuse Corp., Brooklyn, an active SAE technical committee member for more than 20 years (right), with his son **S. G. JR.,** an SAE Enrolled Student at M.I.T., who served in the AAF overseas. His father was a lieutenant commander in the U. S. Navy during the war.

Head of M.I.T.'s Mechanical and Aeronautical engineering departments and chairman of NACA, **JEROME CLARKE HUNSAKER** (M '27) and his son, **J. PETER,** (J '41) principal engineer, Jackson Moreland, Boston consulting engineers. He served in the U. S. Navy as an ensign, assigned to the Engineering Experiment Station, Annapolis.

Chrysler Corp. vice-president and finance committee chairman **B. E. HUTCHINSON** (right) who has been an SAE member for more than 20 years, and his son **JOHN M. S.,** (J '38) who is on special assignment with the Amplex Division of the corporation, Detroit.



Having received his discharge from the U. S. Army, **JOHN RUSSELL HAHNE** joined the A. O. Smith Corp., in Kankakee, Ill., as process engineer.

Recently becoming research engineer of Kaiser Fleetwings, Inc., Bristol, Pa., **FRANK E. MILLER** was design engineer of Rheem Mfg. Co., Eddystone, Pa.

Now sales manager of the Vesper Co., Glendale, Calif., **RALPH H. SWAISGOOD** was president of Pentar Corp.

After service in the Armed Forces **WAYNE J. FAUST** has become chemical engineer, Universal Oil Products Co., Riverside, Ill.

EDWARD S. COBB has recently become sales engineer with Atlas Supply Co., Newark, N. J.

A former lieutenant in the Navy, **HOWARD MORRIS DORWARD** is now assistant wire rope engineer, Colorado Fuel & Iron Corp., Denver, Colo.

Until recently named designer, Allis-Chalmers Mfg. Co., Springfield, Ill., **CLIFFORD R. FEILER** was junior design engineer, Diesel Engine Co., St. Louis, Mo.

PHILIP H. ARBUCKLE is now product design engineer of General Electric Co., Schenectady, N. Y.

In his first public address since joining the Ford Motor Co. last May, **ERNEST R. BREECH,** director and executive vice-president recently voiced his views on such matters as company losses during 1946, the profit and loss system, labor, bigness in business and other vital issues. He said in part "When management told its employees last December that it would have to lose, after the proposed wage increases, something like $65,000,000 in 1946, it wasn't fooling.

"Actually the Ford Motor Co. during the first three-fourths of this year lost $51,600,000 despite two price increases granted the company, one in March and one in May. There was a third price increase late in September which had little effect on these results."

He explained that this loss of $51,600,000 was before possible tax rebates, and that the amount of tax carry back cannot be determined accurately until the results of the full year's operations are known. Had this loss represented the full year's operating results, the tax carry back would have reduced the loss to $32,900,000, he added.

Formerly engineering checker for Lockheed Aircraft Corp., **E. J. GARDEY** is now writing and doing research work. He can be contacted at 11921 Laurel Hills Road, Studio City, Calif.

Resigning from McCulloch Aviation, Inc., Los Angeles, **ELLSWORTH D. WILKIN** has taken a position as assistant chief engineer in charge of engineering at Salsbury Motors, Inc., Pomona, Calif.

WILLIAM ST. GERMAIN has resigned as laboratory engineer, Air-cooled Motors, Inc., Syracuse, in order to work in the propulsion division of Boeing Aircraft Corp.

ROBERT A. WOLF, chief helicopter design engineer, Bell Aircraft Corp., has been transferred to Niagara Falls, N. Y., from Buffalo.

Previously employed by Bendix Aviation Corp., South Bend, Ind., **HERBERT HIRAM THURSTON** is now design engineer of the lift truck division, Ross Carrier Co., Benton Harbor, Mich.

Now affiliated with Curtiss-Wright Corp., Airplane Division, Columbus, Ohio, **WALTER S. TAYLOR** was senior draftsman, Glenn L. Martin Co., Baltimore.

The Board of Directors of the Colgate Aircraft Corp. announces that the name of the company has been changed to Colgate Mfg. Corp., Amityville, L. I., N. Y. There have been no changes in the ownership or management of the company.

Having been released from the U. S. Navy, **AMOS EDWARD SHEPARD** is now engine designer of Pratt & Whitney Aircraft, Division of United Aircraft Corp., East Hartford, Conn.

Previously assistant to the general manager of the Detroit Transmission Division, **ROBERT M. SCHAEFER** is now chief engineer of the commercial transmission department of the Allison Division, General Motors Corp., Indianapolis, Ind.

Resigning as senior engineer, General Motors Corp., Oldsmobile Division, **A. M. WAUTERS** has become carburetor engineer of the automotive research department, Ford Motor Co., Dearborn, Mich.

JOHN FREDERICK SWIFT has been promoted from transmission engineer to senior project engineer-torque converters, Ford Motor Co., Dearborn, Mich.

■

L. J. DAVIS is now general manager of Bickle-Seagrave Ltd., Woodstock, Ontario, Canada, manufacturers of fire fighting apparatus of all types. Operating for about 40 years under the control of the Bickle family, it was recently taken over by the Vincent Mining Corp. of Canada.

C. H. BAXLEY, vice-president and technical director of Intava, Inc., N. Y., recently completed a survey trip to the principal countries of South & Central America in connection with the servicing of international airlines with aviation petroleum products. His 15,000 mile trip was made by air.

KENNETH E. LYMAN, former head of the engineering department of DePaul University, Chicago, & technical advisor to many large industrial organizations like Bendix & Borg-Warner has joined the Tucker Corp., Chicago, to supervise engineering in connection with production of the new rear engine automobile.

Formerly director of research and patents with the Gerotor May Corp., Baltimore, Md., **RIVINGTON STONE** is now a consulting engineer specializing in hydraulics, and can be located at R. F. D. #1, Foley, Alabama. He was born in New York City and attended Stevens Institute of Technology, Hoboken, N. J.

RALPH A. HOXIE, who was project engineer for Continental Aviation & Engineering Corp., Detroit, has been named president of the Basic Service Corp., Detroit, which is engaged in sales and development engineering.

Resigning as field representative from the United Aircraft Service Corp., East Hartford, Conn., **J. B. SPRINGFIELD** has been appointed general manager of Indiana Air Service, Inc., South Bend, Indiana.

WARREN M. MERRILL who was with the General Engineering & Design Co., Los Angeles, has now become inspector for General Tire & Rubber Co., Pasadena, Calif.

RUSSELL H. McGUINEY has been promoted to field engineer of Ethyl Corp., Philadelphia.

A former ensign in the U. S. Navy, **WILLIAM ALISON MARSHALL** is now mechanical engineer of the New Jersey Zinc Co. of Pennsylvania, Palmerton.

R. W. MARRIOTT who was a flight lieutenant is now command motor transport officer of the Royal Canadian Air Force at Western Air Command, Vancouver, B. C., Canada.

Prior to joining Ingersoll-Rand Corp. of Phillipsburg, N. J., **WILLIAM DEIN LEWIS** was a lieutenant in the Navy.

Having served as assistant procurement officer in the U. S. Navy, **ROY GEORGE LAGRANT** is now operating shift engineer, Michigan Consolidated Gas Co., Detroit, Mich.

Resigning as research engineer of Perfex Corp., Milwaukee, **DANIEL H. LAMB** is now associated with the Gates Rubber Co. of Denver, Colo., in the capacity of development engineer.

Graduating from California Institute of Technology, **JEROME S. FIELD** is now mathematician for Hughes Aircraft, Culver City, Calif.

Prior to becoming design engineer for Link Aviation Corp., Binghamton, N. Y., **FRANK EDWARD DELLARD** was procurement engineer, Remington-Rand, Inc., Johnson City, N. Y.

HENRY BJELLAND, service department, Ford Motor Co., has been transferred from Dearborn, Mich., to Chicago, Ill.

GERALD LOUIS BADER, who resigned from Baldwin Locomotive Works, Philadelphia, is now chief engineer of Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Mo.

Promoted to supervisor of the Light Products Division, Socony-Vacuum Oil Co., Inc., Paulsboro, N. J., **THOMAS L. APJOHN** was assistant to the director, N. Y.

RUDOLPH F. RIESZ has resigned from Ryan Aeronautical Co., and taken the position of project engineer for Solar Aircraft Co., San Diego, Calif.

Previously hydraulic test engineer, Warner Aircraft Corp., Detroit, **MARTIN J. NEUMEYER** is now mechanical engineer, diesel laboratory, Ex-Cell-O Corp., Detroit, Mich.

A graduate of Oregon State College, **WILLIAM T. RIHA** is now plant engineer of Carboloy Co., Inc., Detroit.

W. LAURENCE LePAGE, until recently president of Platt-LePage Aircraft Co., Eddystone, Pa., has resigned to enter the consulting engineering field at 1700 Walnut Street, Philadelphia 3, Pa. He will specialize in aviation engineering work on reports, surveys, and design. He has frequently presented technical papers before the Society and other engineering organizations, and is a past-chairman of the Philadelphia Section. Completing his formal education at St. Paul's, London, LePage was appointed a dynamicist at the National Physical Laboratories, and was elected a member of the Institute of Aeronautical Engineers. In 1923 he became a research associate at M. I. T., and from 1925 to 1927 was editor of Aviation. He then was appointed assistant to the vice-president of Pitcairn Aviation, Inc., and in 1929 was appointed executive engineer of Kellett Aircraft Corp. He served the Department of Commerce on a Fact Finding Committee on safety. He is author of "The ABC of Flying."

Formerly sales engineer with Vickers, Inc., **FRANK H. SMITH** has become a partner of Dura-Block Co., Roscoe, Calif.

PARKER JAMES ADAMS has been elected vice-president and general manager of Dudley Parkins, Inc., San Francisco. He had been superintendent of service of Les Vogel Chevrolet Co., in that city.

ALDEN HONORED; HOFFMAN SPEAKER AT OLD TIMERS

HERBERT W. ALDEN, SAE Past-President and Timken Axle's director of engineering, received a Distinguished Service Citation from the Automobile Old Timers at its annual meeting in New York, Nov. 20. Studebaker President **PAUL G. HOFFMAN** was principal speaker at the meeting.

Col. Alden's citation, presented by SAE Secretary and General Manager **JOHN A. C. WARNER,** dubbed the Colonel "dean of Axle engineering," detailed his major contributions to U. S. Army Ordnance development, described his help to SAE since its foundation in 1905, and praised his service to industry through 37 years of engineering achievement with the Timken-Detroit Axle Co. Presenting the citation, Warner said that "Col. Alden smokes a very peaceful pipe, but his daily yield to peacetime engineering – 'get-up and git' – is militant and dynamic."

Hoffman proposed that American industry "vigorously challenged the notion that we should sit idly by and permit the coming of a disastrous business collapse." He urged taking a long hard look at our economic system to find out what causes business fluctuations, suggested means to check inflation and concluded that "we have more than an even chance to achieve our goal" of reasonable economic stability.

(Left to right) Paul G. Hoffman, Col. H. W. Alden, John A. C. Warner

DR. ALBERT A. ARNHYM, consulting engineer and aeronautical writer of Dayton and San Diego, Calif., has been commissioned a colonel in the U. S. Army and appointed deputy chief for technical operations, Air Documents Division, Technical Intelligence, Air Materiel Command, Wright Field, Dayton.

R. H. PREWITT, formerly vice-president in charge of engineering, Kellett Aircraft Corp., has established the Prewitt Aircraft Co., Wallingford, Pa., He is continuing as chairman of Committee S-2, Helicopters of the SAE Special Aircraft Projects Subdivision, has been a leader in exchanging technical information among helicopter manufacturers and has been active in developing specifications and standards for use of helicopter designers and manufacturers.

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ARTHUR M. RHODES has been named an inspector at the Pasco General Depot, War Assets Administration, Pasco, Wash. He was formerly on the staff of Lee & Eastes, Seattle.

Fundamentals of cargo aircraft design and operation are fully described in a new book by **W. W. DAVIES,** superintendent of the Aircraft Planning Division, United Air Lines, Inc. Developing the basic philosophy of cargo aircraft, Davies evaluates the broad aspects of design of this type of aircraft, particularly such related factors as flying cost, payload, loading equipment, and ground handling. Complete analyses showing where compromises in design must be made to suit certain operation limitations are included. Equations for cost predictions are unique in book form. New designs for cargo craft, rather than suggested modifications of airplanes designed for passenger use, are one of the book's special features.

RICHARD REINHEIMER, until recently experimental test superintendent at Ranger Aircraft Engine Division, Fairchild Engine & Airplane Corp., has joined Stratos Corp., Babylon, L. I., N. Y.

PHILIP S. WEBSTER has been promoted to layout draftsman in the Aircraft Engine Division, Continental Aviation & Engineering Corp., Muskegon, Mich.

New fleet manager for Gentile Bros. Co., Cincinnati, is **JOHN D. ZERBO.**

The former Detroit district manager of Shakeproof, Inc., **JOHN B. O'CONNOR,** has been appointed chief engineer of the Illinois Tool Co. He succeeds **WALTER M. HANNEMAN,** who resigned to become chief engineer of SEMS. **RUSSELL H. MAUDE** was named sales manager of the Detroit district.

DR. RAY P. DINSMORE, vice-president in charge of research and development, Goodyear Tire & Rubber Co., urged prompt action by Congress to prevent destruction to the American synthetic rubber industry. Speaking before the American Institute of Chemical Engineers, Nov. 21, at Charleston, W. Va., he said that return of unrestrained bidding for natural latex would wreck the new synthetic industry and thus retard chemical progress, impair national security, and cost the nation millions of dollars in upped prices of crude natural rubber.

Appointed chief test engineer for Ranger Aircraft Engines Division, Fairchild Engine & Airplane Co., **FRANK J. HAHN** had been design engineer with the Standard Oil Co. (Ind.) at Sugar Creek, Mo.

JOHN F. CREAMER, president of Wheels, Inc., has announced expanded branch activity of the company at Newark, N. J., and Albany, N. Y.

W. DEAN BURTON is chief mechanical engineer of Consolidated Steel Corp., Ltd., Los Angeles.

Until recently chief engineer of Wright-Thompson, **J. W. HARLEY, JR.,** is now engineer and designer for Cappart Corp., Owosso, Mich., manufacturers of automotive products.

T. P. WRIGHT, administrator of Civil Aeronautics, is chairman of the new CAA-CAB Committee to consider problems of mutual concern to the agencies, and make final decision. Representatives of both CAA and CAB are members of the new group. They are Clarence M. Young, co-chairman; A. S. Koch, Wallace S. Dawson, R. P. Boyle, and Merrill Armour. Executive secretary is John Marshall.

GEORGE H. TABER, JR., executive vice-president of Sinclair Refining Co., has been elected vice-president of the American Standards Association, it was announced at the ASA annual meeting Nov. 22.

Appointment of **JAMES M. SKINNER, JR.,** as general manager of the Accessories Division of Philco Corp., Philadelphia.

HAROLD WINSLOW PAINE is an assistant engineer of manufacture with Western Electric Co., Kearney, N. J. He had been with the Elco Naval Division of Electric Boat Co. of that city.

FRED A. GENESS has been named Detroit office manager of Reynolds Metals Co., **FRANK W. LYNCH,** assistant general manager of the company's Automotive Division, announced.

Formerly chief engineer, **HUGO H. WERMINE** has been elected vice-president in charge of plant, development, and research engineering of the Belden Co., Chicago. He joined the company in 1919 as a chemist.

ROBERT E. REEDY has been appointed sales manager of Thorp Aircraft Co., Van Nuys, Calif. He had been chief project engineer of Lockheed Aircraft Corp. in the special projects branch.

CAPTAIN IDE DECORATED

CAPTAIN JOHN JAY IDE, USNR, is shown receiving the Commendation Ribbon from Admiral R. L. Conolly, Commander, Twelfth Fleet, for outstanding performance of duty as Technical Air Intelligence Officer on the staff. He returned to the U. S. after three years' duty at one American Embassy, London, where he served as the assistant naval attache for air. Prior to his London assignment he headed one foreign Intelligence Section in the Bureau of Aeronautics.

C. K. SENCEBAUGH has been named project engineer for Kelco Co., San Diego, Calif., manufacturer of chemical stabilizers. He had been chief mechanical engineer of the plant engineering department of Higgins Aircraft, Inc., New Orleans.

An SAE member for the past 25 years, **NORMAN N. TILLEY** has joined Engineering & Research Corp., Riverdale, Md., as powerplant engineer. Formerly a consultant on aircraft engines, Tilley has been active on numerous SAE technical committees, served as SAE vice-president in 1941, and a member of the Manly Memorial Board of Awards for three years and was the group's chairman in 1944. He also was vice-chairman of the Detroit Section.

ALBERT W. FREHSE has been appointed chief engineer of the Engineering Testing Department, Ford Motor Co., Dearborn, Mich. He had been an engineer in the Central Office of Chevrolet Motor Division, General Motors Corp.

Until recently an engineer with the American Standards Association, **FREDERIC R. SPEED** has been appointed a lubricants and fuels technologist of the Procurement Bureau of the U. S. Treasury, Washington, D. C. During the recent war he was a consultant with the War Production Board.

ARCHIE R. BURGESS has been appointed assistant professor of mechanical engineering at Washington University, St. Louis. He was released from the Army recently with the rank of captain, and had been assigned to the St. Louis Ordnance District.

Released by the Navy where he had served as an ensign, **DONALD GEORGE RAMBACHER** has been named an engineer on jet powerplants by the NACA Aircraft Engine Testing Laboratory, Cleveland.

WILLIAM J. SCHLAPMAN, formerly advertising and sales promotion manager, Young Radiator Co., Racine, has been appointed service representative of Ford Motor Co. at Milwaukee.

Relieved of active duty as an ensign in the U. S. Navy, **JOSEPH HENRY RICHARDS** has been appointed an engineer with Twin Coach Co., Kent, Ohio. He had been on the staff of the commander of the Philippine Sea Frontier.

GEORGE THARRATT has returned to Douglas Aircraft Co., Inc., Santa Monica, Calif., as designer on preliminary design. Upon leaving the company some time ago he was with Adel and later in private consulting engineering practice.

Following an extended vacation in the east, **FRANK W. FURRY** has joined the Pacific Division, Bendix Aviation Corp., as an aerodynamacist. During the past six years he had been on the engineering staff of North American Aviation, Inc.

KENNETH C. SMITH, until recently a chief motor machinist in the U. S. Navy, is now operating assistant for General Petroleum Corp., Los Angeles.

Formerly technical assistant to the president of Bol, Ltd., New York, **MARTIN STARK** is a research engineer with Standard Oil Co. (N. J.), Elizabeth, N. J.

JAMES M. STANKARD has joined Visioneering, Inc., Cleveland, as a machine designer. He had been with Design Service Co. of that city.

Formerly an instructor in machine shop practice for the Government at Fort Devens, **ERNEST O. WHEELER** is now head of the general shop of arts and industries, Acton High School, Acton, Mass.

CARL WILLIAM FLOSS has joined Ford Motor Co., Dearborn, Mich., as a development and design engineer. He had been assistant chief engineer of the Detroit Gear Division, Borg-Warner Corp., Detroit.

Resigning from International Nickel Co., Inc., Bayonne, N. J., **THOMAS HARDGROVE** has joined Stewart-Warner Corp. as assistant plant engineer at the Indianapolis plant.

THOMAS M. WALSH has been named superintendent of maintenance for Neibauer Bus Co., Bristol, Penna. He had been with the Baltimore Transit Co.

Until recently research engineer with Shell Oil Co., Inc., Wood River, Ill., **TURNER G. TIMBERLAKE** is a project engineer of the U. S. Naval Engineering Station, Annapolis, Md.

CYRIL GEORGE GRIFFIN, formerly director of Vauxhall Motors, Ltd., and A C Sphinx Sparking Plug Co., Ltd., is joint managing director of Griffin & Dyer, Ltd., automotive consultants with offices at 1 Maclise Road, London W14, England.

Released from the U. S. Army Signal Corps as field engineer, **GEORGE D. JOHNSON** is automotive engineer with the Veterans Administration, New York City.

LLOYD W. JEDEKA is now mechanical engineer for Mitchell Camera Corp., Glendale, Calif.

OBITUARIES

EARL W. KIMBALL

Earl W. Kimball, industrial lubrication service engineer, Gulf Oil Corp., N. Y. C., died November 16, after a long illness. After serving four years in the Navy he was employed in Syracuse by the Franklin Auto Co., with whom he remained 11 years as factory service manager. In 1919 he came to Buffalo and became vice-president of the Ostendorf Motor Corp., which he helped to organize. Four years later he was lubrication engineer for Vacuum Oil Co., and after that joined Gulf. Mr. Kimball was chairman of the Buffalo Section of the SAE 1928-1929.

EDWARD G. BUDD

A pioneer in the manufacture of pressed steel part, Edward G. Budd, founder in 1912 of the $80,000,000 company which bears his name, died November 30, at the age of 75. He joined the SAE in 1914.

Requiring a press too large for his little shop which he acquired following his apprenticeship as a tool maker and manufacturer of pressed steel products, he rented a circus tent and pitched it on a vacant lot nearby and went into production of automobile and truck bodies.

In his early years he attended Franklin Institute and took correspondence courses to learn fundamentals of engineering, and in 1944 received the ASME medal for "outstanding engineering achievements."

His first automobile body contracts were with Charles Nash, then president of General Motors, and, two years later, with John and Horace Dodge, then engine builders who had just entered the automobile business with the Dodge automobile and truck lines.

He pioneered the steel wheel, stainless steel fabrication, and in April, 1934, delivered to the Chicago, Burlington & Quincy Railroad its first Burlington Zephyr stainless steel train. His company was the first concern to manufacture the bazooka for the Army, and was responsible for millions of bombs and other weapons. Throughout his active career he was always counted on by fellow Philadelphians as a civic and community leader.

FRANK E. WICKHAM has been appointed vice-president and chief engineer of Flexible Products Co., Detroit. He had been chief engineer, Bushings, Inc., Berkley, Mich. A former Air Corps officer, he barnstormed with Jack O'Mara with gliders and airplanes, and was in sales promotion work with Packard Motor Car Co. for nearly 10 years.

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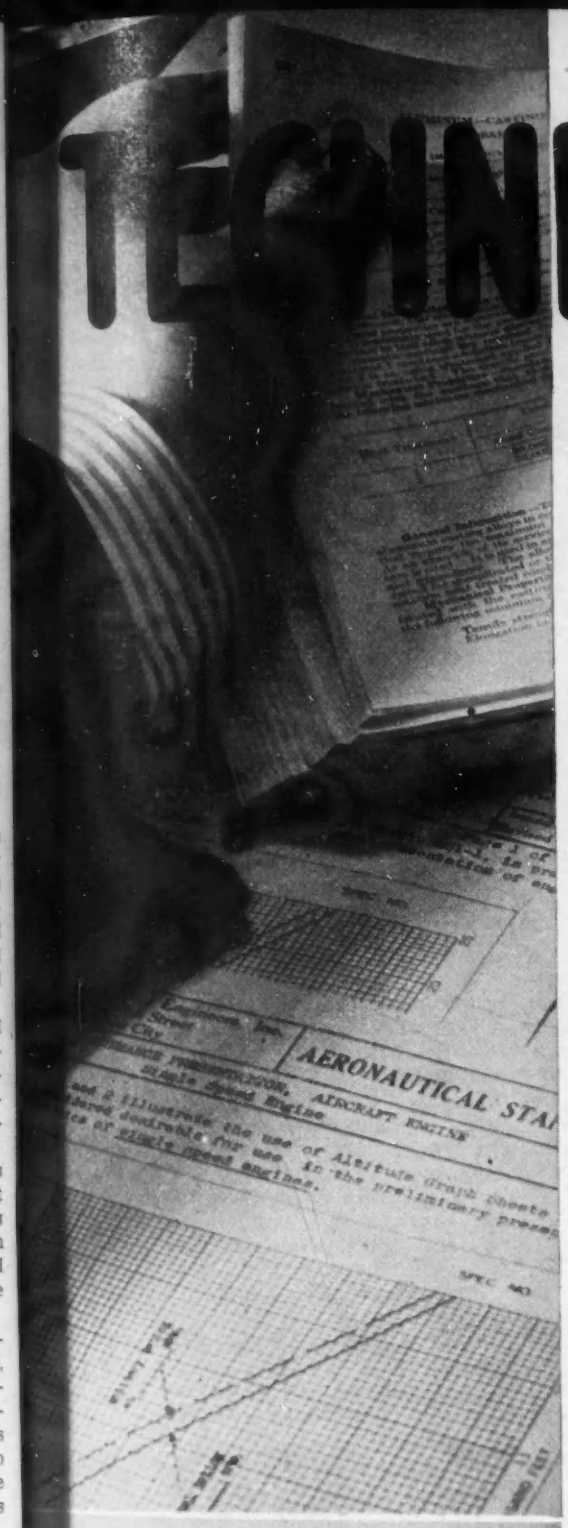

TECHNICAL COMMITTEE PROGRESS

SAE to Steer Work On Plane Standards Over Clear-Cut Road

SAE's participation in the job ahead on standards and specifications for both military and civil aircraft accessories and equipment is now clearly defined by policies agreed upon by industry, Government, and other interested organizations.

This new understanding makes possible streamlined handling of Army-Navy standards and simplification of CAA acceptance of civil aircraft products. By doing so, it enables committees of the SAE Aircraft Accessories and Equipment Subdivision to be of greater assistance to both industry and Government, reports Subdivision Chairman W. C. Lawrence, American Export Airlines, Inc.

Important in development of AN standards is the new industry-Government relationship in this area. The Aircraft Industries Association will now serve as a single point of contact for the Aeronautical Board Working Committee (WCAB) on all proposals – new and revised – concerning AN specifications on which industry comments are desired. The proposal will be circularized to the industry by AIA. (Any company not already on the AIA list that desires to be included should write to I. C. Peterson, Director, Technical Services, Aircraft Industries Association, Shoreham Building, Washington, D. C. Indication should be given of those particular types of aircraft equipment for which copies of proposed specifications are desired for review and comment.)

A period of 30 days will be allowed for this preliminary check. No reply is required if there is no objection.

However, should an objection to the AN specification in question be received, the matter will be referred by AIA to the appropriate standardizing body. SAE is only one of a group of organizations that will handle these matters. Other societies and trade associations such as the Tire & Rim Associa-

SAE TECHNICAL BOARD

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R. M. Insley — Mac Short
E. D. Kelly — T. C. Smith
G. W. Laurie — V. C. Young

J. C. Zeder

Important policies were shaped at the last meeting of the SAE Aircraft Accessories and Equipment Subdivision. Standing, in the usual order, are Edmund Thelen, Eclipse-Pioneer Division, Bendix Aviation Corp.; C. V. Johnson, Bendix Products Division, Bendix Aviation Corp.; I. C. Peterson, Aircraft Industries Association; A. W. Dallas, Air Transport Association; H. D. Hoekstra, Civil Aeronautics Administration; W. C. Jamouneau, Piper Aircraft Corp.; H. M. Hucke, RCA Mfg. Co., and J. C. Shaw, Young Radiator Co. Seated are Edith Becker, SAE Staff; J. D. Redding, SAE Staff; J. M. Roth, Mechanisms Co.; B. R. Terre, The Weatherhead Co.; Chairman W. C. Lawrence, American Overseas Airlines, Inc.; L. J. Henderson, The Weatherhead Co., and M. L. Stoner, SAE Staff. Sub-division members not present are M. E. Chandler, Chandler-Evans Corp.; W. W. Davies, United Airlines, Inc.; W. H. DuBois, Bendix Products Division, Bendix Aviation Corp.; J. J. Hilt, Young Radiator Co.; Paul Kollsman, Kollsman Instrument Division, Square D Co.; Erle Martin, Hamilton Standard Propellers; R. L. McBrien, United Airlines; T. R. Thoren, Thompson Products, Inc.; Jack Vitol, Civil Aeronautics Administration, and J. F. Wallace, Cleveland Pneumatic Tool Co.

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tion and the Radio Manufacturers Association also will serve as consulting or sponsoring agencies.

The sponsor to whom the controversial specification is referred will be responsible for conducting a thorough industry survey and developing an acceptable recommendation. Although the time limit for this operation is set at 60 days, the sponsor may obtain an extension if necessary.

Its recommendation and a summary of its survey will then be submitted by the sponsor to AIA for transmission to the WCAB.

This plan makes possible swift processing of any request on AN specifications and insures handling of each problem by the best qualified organization while still retaining AIA as a single point of contact between the WCAB and the aircraft manufacturing industry. Industry aid to the military services is now geared to a high order of efficiency.

Approving Civil Aircraft Accessories

Recent regulations placing civil aircraft accessories and equipment – in addition to propellers, engines, and airframes – under CAA jurisdiction would have stymied both manufacturers and operators of personal airplanes and air transports had not SAE been accepted by both sides as the source for acceptable minimum performance specifications.

Under the original CAA plan, the accessory manufacturer would have been required to prove the performance of each of his products before receiving CAA approval for flight service. But use of the product in flight would not have been permitted without CAA approval.

To break this impasse, the SAE will develop minimum performance specifications requested by industry and the

concluded on p. 93

New Doors to Helicopter Design Unlocked With Keys to Better Wheels and Transmissions

SAE's continued contribution to helicopter design is typified by two newly issued information reports on characteristics of helicopter wheels, tires, and brakes and on testing of helicopter transmissions. Integrating experience to date, the SAE Helicopter Committee is blazing a pioneering trail for existing and potentional helicopter industry.

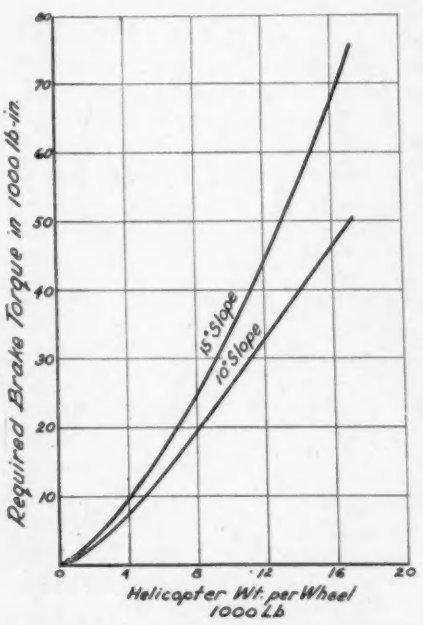

Fig. 1 – This chart shows how much torque the brake in each wheel must develop to hold the helicopter on sloped ground

These two reports provide the helicopter designer with (1) a guide to selection of proper wheels, brakes, and tires and with (2) a rapid yet economical method of checking new transmissions.

In Aeronautical Information Report No. 15, Desired Characteristics for Helicopter Wheels, Tires, and Brakes, the Committee offers both helicopter designers and parts manufacturers performance criteria desired of these items. It says that standard airplane brakes and wheels can be adapted to helicopters but that tires should be special.

Stopping the helicopter in forward run on the ground and steering and taxiing are generally considered functions of flight controls rather than the brakes, as in conventional aircraft. Therefore, rate of deceleration, dissipation of heat, and life expectancy generally are not considered in specifying characteristics of helicopter wheel brakes.

But if a helicopter is used for training, particularly in the technique of power-off landings, individually-operated brakes would be advantageous for steering and stopping. For this reason the report recommends installation of the same type of wheel brakes and controls used in conventional airplanes for helicopter steering and deceleration.

Another consideration in brake design is that power-off helicopter landings should not require more than 100 ft of roll with ground contact at 40 mph. Under normal conditions, about 10 power-off (emergency) landings

during the life of a helicopter can be assumed.

For parking, brakes should be designed to hold the helicopter on ground sloping at least 15 deg so that adequate braking force against wind will be provided. (Design for a 20-deg slope might be necessary for shipboard operation.) For high winds or rolling decks, mooring will be required.

This specification is considered satisfactory for counteracting any unbalanced torque that might react on the wheels when clutching-in to start the rotor.

Parking brakes, continues the report, should be operated from the cockpit with a single hand or foot control; a locking pin in the wheel is not adequate. Any standard aircraft wheel brake system – hydraulic or mechanical – will do.

Fig. 1 shows required brake torque plotted against helicopter weight per wheel for the 10-deg and 15-deg conditions. To hold the helicopter on a 15-deg slope will require a force of G x Sin 15 deg, giving 0.259G or 0.013G per wheel as compared to 0.31G per wheel for conventional airplanes. Standard airplane braking systems can be modified for helicopters by reducing brake energy capacity to the extent indicated.

Magnesium wheels presently manufactured for conventional airplanes should satisfy the light-weight criterion in helicopter design. But wheel bearings cannot be eliminated.

Special tires for helicopters have been manufactured since the Tire and Rim Association recognizes that operating conditions of helicopter tires are different. By rating maximum load capacities at 1.5 times the rating of conventional airplane installations, a smaller and lighter tire for a given helicopter load has been produced. Weight also has been saved by reducing tread and sidewall rubber. Progress is reported in developing a good degree of internal damping in these special helicopter tires.

Designers are advised that wheel and tire size may be determined by rolling radius required and by flotation in soft earth, sand, and mud. Wheels and tires selected solely for static load needs would be too small to meet these additional requirements.

Chairman of the subcommittee that prepared this report is R. A. Price, of McDonnell Aircraft Corp.

Testing Transmissions

The second new report, AIR No. 14, Preliminary Testing of Helicopter Transmissions and Design Life of Helicopter Transmissions, emphasizes the importance of transmission tests.

It deals with deflection and endurance bench testing, pointing out that although bench tests give results in a minimum of time, most convincing

Colwell to Head Technical Board

A. T. COLWELL has been named chairman of the SAE Technical Board for 1947. A past-president of the Society and vice-president of Thompson Products Corp., Mr. Colwell succeeds retiring Board Chairman J. M. Crawford.

Eight new members have been named by the president to begin three-year terms in 1947, in accordance with Board regulations which call for retirement of one-third of the Board membership each year. The new appointees are:

W. G. Ainsley, Sinclair Refining Co.; W. J. Blanchard, Aeroproducts Division, GMC; J. M. Crawford, General Motors Corp.; W. P. Eddy, Jr., Pratt & Whitney Aircraft; R. M. Insley, Continental Motors Corp.; Elmer McCormick, John Deere Tractor Co.; G. A. Page, Jr., Curtiss-Wright Corp., and V. C. Young, Wilcox Rich Division, Eaton Mfg. Co.

Board members whose terms expired at the end of 1946 are: D. P. Barnard, Standard Oil Co. of Indiana; R. B. Beisel, Chance-Vought Aircraft; R. M. Hazen, Allison Division, GMC; Erle Martin, United Aircraft Corp.; Arthur Nutt, Packard Motor Car Co.; L. S. Pfost, Massey-Harris Co.; R. R. Teetor, Perfect Circle Corp., and R. W. Young, Wright Aeronautical Corp.

This marks the end of the first full year for the Technical Board, the group which supervises and steers the Society's large program of technical committee activities.

A. T. Colwell

W. G. Ainsley

W. J. Blanchard

J. M. Crawford

W. P. Eddy, Jr.

R. M. Insley

Elmer McCormick

G. A. Page, Jr.

V. C. Young

tests are conducted by mounting the transmission on the aircraft and running it under actual conditions. But bench tests are speedier and less costly because no delay is encountered by breakdown of other helicopter elements.

Test procedure recommended in the report is divided into these four phases:

1. Static deflection tests;
2. Dynamic tests at slow speed to determine deflection characteristics;
3. No-load rotational tests to determine lubricating characteristics, and
4. Dynamic endurance tests at normal speeds and loads.

Static deflection tests are useful in determining alignment of bearings and gears. If deflection in static tests is excessive, producing severe end-loading of bearings and gears, corrective measures can be taken before damage is done. Change in design can be rechecked before undertaking costly bench endurance tests or complete aircraft type tests.

Slow rotation tests at ¼, ½, ¾, and full load determine probable adequacy of spiral gear trains. Deflection of gears, shaft, bearings, and housing can be observed by mounting indicators at numerous points. Probable service life of new gears can be predicted by comparing deflection results of the new design with similar test results on gear boxes of known service history.

Third test, no-load rotation, is useful for checking lubrication characteristics for two reasons. Firstly, it reveals whether lubricant is reaching all bearings and gear teeth – if gears are oil cooled. And secondly, it also tells whether excess lubricant is being dammed up at points where parasitic heat will be produced by hydraulic action of the oil.

Confirmed in the dynamic endurance tests, last phase of preliminary transmission bench-checking, are the conclusions reached in the previous tests. The report points out that the back-to-back coupling has frequently and successfully been used in endurance tests.

Described as the most ideal arrangement for regenerative or back-to-back testing of a straight-drive planetary reduction system is a solid coupling of the output shafts and the two reduction shafts. The two input shafts are interconnected with a shaft running through the output shafts. One gear housing can then be rigidly mounted and the other loaded to the desired test torque through a torque arm. A small motor drives the input shaft and need supply only the friction torque.

By this arrangement, friction losses can be measured directly with greater accuracy than by trying to determine the difference between large input and output horsepowers. With the transmissions vertical, the upright one is considered the test transmission and the upside-down one the dummy. The report justifies the reliability of efficiency data obtained with this configuration despite the need for modified oil cooling for the inverted position unit.

How to preclude failure of the dummy transmission before the test transmission fails is shown as well as alternate arrangements for transmission testing.

Although efficiency data can be obtained in this test, the report proposes the back-to-back test principally as an endurance testing means, and only incidentally as a reasonably satisfactory method for determining efficiency.

A run of at least 100 hr at normal rated power and speed is recommended for these endurance tests to reveal possible sources of trouble during the early flight stage. If the transmission is to be tested for 500-hr overhaul period, 200 to 300-hr bench tests are recommended.

The report concludes with formulas and instructions for computing probable life of the transmission from test data. It says, however, that only by accumulating experience can a ratio be established of life under test conditions versus life under actual flight conditions.

Responsible for developing this report was a subcommittee under the chairmanship of M. Wachs, of Sikorsky Aircraft.

These two reports and a previous one on testing for ground resonance (See November, 1946, SAE Journal, p. 81) form a nucleus of original material that promises to enrich the literature on the art of helicopter design. Some 20 other reports already are in process and Committee Chairman R. H. Prewitt says that many are well along toward completion.

Identification			DIMENSIONS									
			EXTERNAL THREADS						INTERNAL THREADS			
	Thds. per Inch		Major Diameter			Pitch Diameter		Minor Dia.	Minor Diameter		Pitch Diameter		Major Dia.
Size		Symbol	Max.	Min.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
¼	20	NC-2	0.2500	0.2428	0.2398	0.2175	0.2139	0.1887	0.1959	0.2060	0.2175	0.2211	0.2500
¼	28	NF-2	0.2500	0.2438		0.2268	0.2237	0.2062	0.2113	0.2175	0.2268	0.2299	0.2500
¼	32	NEF-2	0.2500	0.2446		0.2297	0.2265	0.2117	0.2162	0.2208	0.2297	0.2328	0.2500
5/16	18	NC-2	0.3125	0.3043	0.3011	0.2764	0.2723	0.2443	0.2524	0.2630	0.2764	0.2805	0.3125
5/16	24	NF-2	0.3125	0.3059		0.2854	0.2821	0.2614	0.2674	0.2739	0.2854	0.2887	0.3125
5/16	32	NEF-2	0.3125	0.3071		0.2922	0.2889	0.2742	0.2787	0.2833	0.2922	0.2955	0.3125

Note: "A" For semi-finished and finished screws and bolts, threaded portion only.

Fig. 1 – Screw thread tables in the SAE Handbook are being simplified and will look like this. All data for one thread size in one class of fit will be found in one table

Plan Special Fits For Nuts and Bolts

TWO special classes of fits for everyday nuts and bolts being developed by SAE in cooperation with ASA Sectional Committee B-1 will fill a long-neglected need.

Industry has been relying upon combinations of standard classes of screw thread fits for the fabrication of common nuts and bolts. But both manufacturers and customers feel that this class of threads requires a fit or fits tailored to its needs. SAE Screw Thread Committee hopes to satisfy this demand with Class A and B fits designed specifically for nuts and bolts.

One feature these new fits will include is sufficient clearance to allow for plating without setting up metal-to-metal interferences. Allowances also will be established with regard to wrenching torque.

Another project now under way that promises to facilitate use of the SAE Handbook is the consolidation of tables for all standard threads. Whereas pitches, allowances, and tolerances for each thread diameter are now located in separate tables for each class of fit, the new arrangement will give all the information on each screw size in one grouping.

For example, by looking up the ¼-in. screw thread, Handbook users will find in one place all data regarding both external and internal ¼-in. threads in NC, NF, and NEF as well as the 20, 28 and 32-thread series for each class of fit. This is demonstrated by the sample table in Fig. 1. In other words, the tables will be based on diameter rather than pitch.

Third new undertaking announced by Chairman W. L. Barth, General Motors Corp., is the creation of an extended standard on slotted head screws and a new standard on recessed head screws being used by the automotive industry.

"What's My Name?" Busies Truck Group

UNIFORM commercial vehicle nomenclature is another SAE project aimed at fostering greater understanding among engineers by clarifying the technical language.

The SAE Commercial Vehicle Nomenclature Committee does not hope to eliminate colloquialisms used by drivers. But it is intent upon nailing down supposedly common vehicle nomenclature.

The Committee plans to prepare a standard or recommended practice in dictionary form on such terms as motor truck, truck-tractor, 2, 4, and 6-wheel drive, full trailer, and semi-trailer. Chairman F. K. Glynn, American Telephone & Telegraph Co., has appointed an editorial subcommittee under F. B. Lautzenhiser, International Harvester Co., to make preliminary recommendations on some definitions.

This SAE group already has held several meetings and hopes to have ready for the parent Committee several proposals at the next full committee meeting early this month.

Despite the fact that transportation engineers live with vehicles every day, individuals from different areas and even different companies are confused in their communications with other organizations simply because they are not talking about the same thing. With the large variety of truck types now on the scene, it is no longer adequate to label any such vehicle a "truck."

Distinction must be made among

Chairman F. K. Glynn

the different breeds . . . how many wheels does it have . . . what does it tow behind it . . . how is the unit being towed attached . . . and what kind of payload does it carry.

Calling a semi-trailer a trailer or other inaccurate designations can become a serious consequence in Government regulations. Lack of uniformity among state laws is vexing to fleet operators and perplexing to law-enforcing agencies. Improper definitions may be trying not only in court litigation, but can conceivably create inequities in as simple a matter as license plate fees.

Even the vehicle manufacturer is enmeshed in this unplain talk entanglement. His engineers are confronted with shop jargon from all parts of the country with such names as "cackle crate" for chicken-hauling truck and "horse" for tractor.

Serving with Chairman Glynn and Lautzenhiser on the Committee are: Robert Cass, White Motor Co.; M. C. Horine, Mack Mfg. Co.; E. P. Lamb, Chrysler Corp.; W. C. Parker, Diamond T Motor Car Co.; F. E. Sandberg, Ford Motor Co.; A. C. Butler, National Highway Users Conference; J. L. Glick and J. B. Hulse, Truck-Trailer Manufacturers Association; G. T. Hook, Commercial Car Journal; S. A. Jeffries, Studebaker Corp.; G. W. Laurie, Atlantic Refining Co.; T. L. Preble, Tide Water Associated Oil Co.; J. W. Sinclair, Union Oil Co. of Calif.; J. L. S. Snead, Jr., Consolidated Freightways, Inc.; Hoy Stevens, American Trucking Associations, and L. B. Young, Pacific Motor Trucking Co.

New Aeronautic Drafting Report Aims at Standardized Standards

UNIFORMITY in drawings for SAE aeronautical standards and recommended practices is the objective of the SAE Aeronautical Drafting Manual Committee's recently released report.

Development of this report stems from belief of the SAE Aeronautical Committee – steering group of all SAE aeronautic technical committees – that virtues of standardization can be realized in its standards work. It felt

concluded on p. 93

SAE's Aeronautical Drafting Manual Committee capped its recent two-day meeting in New York with a radar demonstration flight up the Hudson River in American Airlines' Flagship Alpha

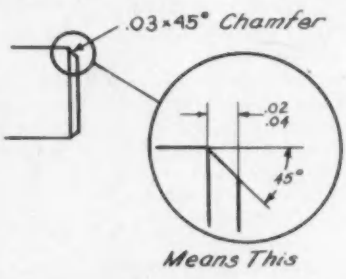

Fig. 1 – One of the common misconceptions to be clarified in a new section planned for the SAE Aeronautical Drafting Manual is the meaning of chamfer notations

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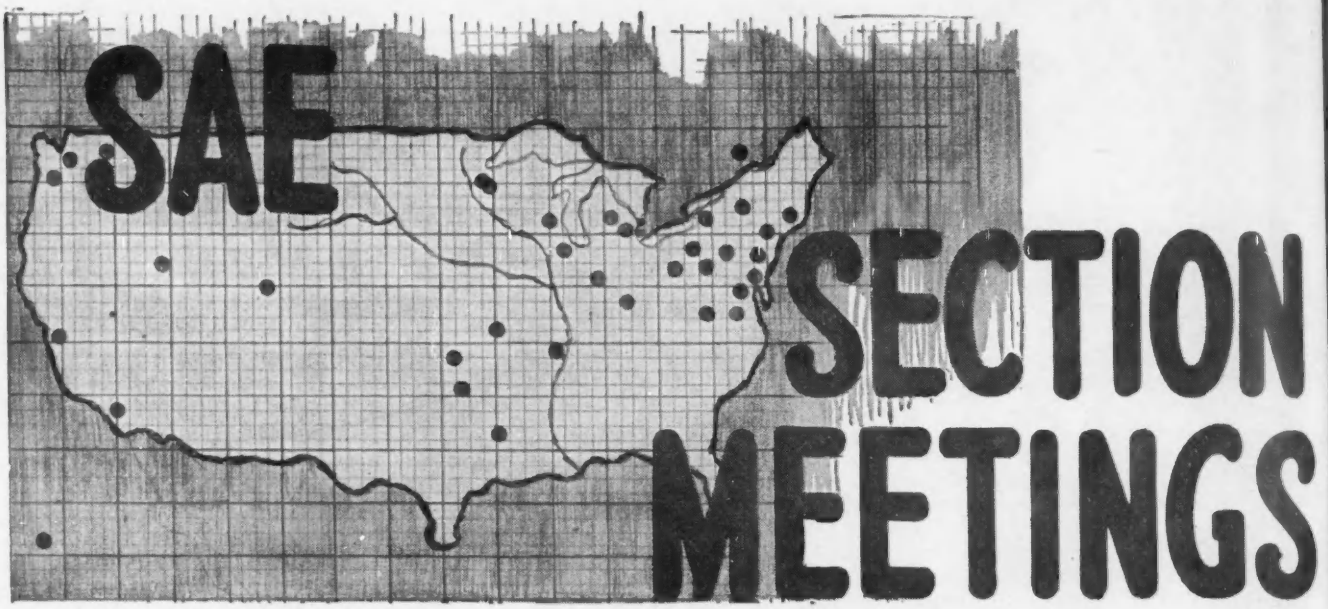
Correction . . .

In the Technical Committee Progress section story, "Hydraulic Standards Cut Plane Weight," on p. 70 of the December SAE Journal, reference was made to inflammable hydraulic fluid. It should have read "nonflammable fluid" wherever "inflammable" fluid was mentioned.



Power Chain Saw Problems Analyzed in Lumber Center

by J. B. TOMPKINS, Field Editor

BRITISH COLUMBIA Group, Nov. 6 – Improper mixing of gasoline and oil in high-speed two-cycle engines used in West Coast power chain saws is responsible for most of the trouble encountered, according to F. Davison, chief engineer of the Industrial Engineering Co., Ltd. Ignition trouble is caused mainly by excessive oiling of the spark plug.

When gas and oil are improperly mixed, he told members at this meeting, some oil settles to the bottom, and the engine gets a slug of almost neat oil which is thrown up onto the cylinder head and spark plug. The 10-mm plug is more sensitive than the 14-mm plug, although the 10-mm plug is more attractive to the designer dealing with a very small bore engine.

Power chain saws, first developed in British Columbia, are used extensively in the Pacific Northwest lumber industries. The saw has a continuous chain running over two sprockets held apart by a thin blade. An adjustable sprocket at the other end attaches the driven end of the blade to the power source and acts as an idler. Two-cycle gasoline engine usually is used.

Major problems in high-speed powersaw operation are cooling, carburetion and lubrication. Though cooling problems are not serious, Davison said, the problem grows as engine bore increases. A special carburetor design with centralized float chamber and submerged jets overcomes problems created by the average carburetor's inability to perform at 45-deg angles.

Davison reported, replying to questions following his paper, that:

1. There is no set rule for quantity of oil in two-cycle engines; engines under different load conditions can tolerate different quantities. Usually a gasoline-oil mixture of 8 to 1 is best. No mixture should be weaker than 12 to 1.

2. Ordinary seals are quite adequate for sealing main bearings if two are used.

3. Large cylinders are only an operator's prejudice; smaller ones would help overcome heat problems.

4. Two-cycle engines have been operated on small power saws as high as 10,000 rpm for 30 min with no difficulties.

5. Present superchargers are too heavy for motors used in power saws.

6. Crankcase sludging results mostly from sawdust.

Springs Paper Brings Spirited Discussion

by D. M. TREPP, Acting Field Editor

NORTHWEST Section, Dec. 6 – SAE members gathered from Vancouver, Tacoma, and other Northwest automotive and fleet centers to hear N. E. Hendrickson speak at the Gowman Hotel in Seattle. His paper on "Heavy Duty Springs" provoked so much discussion that Section Chairman D. D. Thomasson had to call a halt as eleven o'clock approached.

Hendrickson, who is metallurgist with U. S. Spring & Bumper Co., was introduced by H. E. Simi, head of Kenworth Motor Truck Corp.'s Bus Division, who reported that the latest type spring suspensions in the Kenworth buses now being constructed are Hendrickson-designed.

Greater distances, grades and curves on the highways of the Northwest create special demands and special problems, Hendrickson said. But progress in spring suspension on heavy-duty vehicles has been rapid.

Important points touched upon were principles of deflection; frequencies (which range from 90 to as low as 61 in the modern passenger car); economy resulting from highest quality material being used; and importance of proper design and heat treatment. As for materials, Hendrickson said, air is the ideal spring medium but requires units too costly and bulky.

Discussion brought out other points:

- Good spring suspension on trucks with extreme load variations must wait, like air springs, for the future.
- Common sense is an essential supplement to engineering in suspension problems.
- Torsion rod springs are more predictable than leaf springs as to stresses that may develop.
- Tubular torsion springs probably will be prevented by cost from becoming common.
- Responsive springs demand freedom and lubrication.

Fuel Inflammability At Met Section Panel

by C. F. FOELL, Field Editor

METROPOLITAN Section, Nov. 13 – Fuel tests extending over more than a year were dramatized at this meeting by color movies and a comprehensive review by E. M. Barber of the Texas Co. Inflammability tests were carried on under various atmospheric conditions, with fuels ranging from low to medium-high volatility.

Considerations of major importance in testing inflammability, Barber said, are fuel volatility and the nature of

the igniting source (open flame, hot pipe, or intermittent high-voltage current); of minor importance are distance from release of fuel to igniting source, and type of fuel release ("crash" or "spill"). Windage is of little effect, except as it may promote ignition by blowing spray into the igniting source. Quantity of fuel is not critical above about 2 gal at any one release.

George Keller, Section vice-chairman for fuels and lubricants, arranged and conducted the meeting.

Stress Mathematics Explained at Buffalo

by R. J. MARBLE, Field Editor

BUFFALO Section, Nov. 15 – Mathematical treatise on "Stresses and Deformations of Rotating Wheels under the Action of Temperature Gradients, Thrust, and Precessional Loads" was presented here by Roy Krouse, structures chief of Fredric Flader, Inc.

Krouse discussed three major topics:

1. Lateral deformation of turbine wheels, caused by axial components of bucket gas loadings.

2. Lateral deformations of a precessing turbine wheel. (These are low except in spins: the flatter the spin, the more critical the condition.)

3. Stresses and deformations of a rotating wheel with variable radial temperatures.

Helicopter Versatility Insures Bright Future

by R. W. DONAHUE, Field Editor

PHILADELPHIA Section, Nov. 13 – Development of the helicopter industry is just as significant as the turn-of-the-century growth of the automobile industry, Leston A. Faneuf, secretary of Bell Aircraft Corp., told members at this meeting. His paper on "The Helicopter of Today" was prefaced with a sound color film, "The Modern Magic Carpet," which illustrated interesting helicopter applications, and demonstrated its unique maneuverability. Frank Piasecki, president of Piasecki Helicopter Corp., presided as technical chairman.

The helicopter, Faneuf said, need not fly far, fast or high. Other aircraft are specifically designed for those purposes. For airmail service between terminals less than 300 miles apart, the helicopter has a distinct advantage over fixed-wing aircraft. Within five years, he expects every major post office to have a landing platform on its roof. First such landing, he announced, was made in Philadelphia by a man present at the meeting – Lewis Leavitt, operations manager for Helicopter Air Transport.

Faneuf described a geophysical survey made with a Bell Helicopter in the rugged terrain 250 miles north of Toronto last summer, where work normally done by eight men in eight months was done by helicopter in two weeks. In another experiment, a Buffalo power company lineman was flown along 25 miles of high tension power lines for 2 hr. In his report he uncovered three major items overlooked by four men who did the inspection job on foot in 8 hr. He missed one cracked insulator.

Helicopters are particularly useful in crop dusting and pollination, for the downwash of the rotor reaches the underside of the plant. Problem now, Faneuf announced, is not to find uses for helicopters but to improve operational stability and simplify design, fabrication and operation. Time is the major need.

Walter H. Pearson, the section's vice-chairman for Aircraft Activity, introduced many pioneers and leaders of the industry. Among them were Eno Bossi, designer of the Higgins ship; R. H. Prewitt, former vice-president and chief engineer of Kellett Aircraft Corp., now engaged in his own consulting practice; Paul Stanley, chief engineer of the Autogiro Co. of America; Henry W. Austin, U. S. Maritime Commission member; and Elliott Dalen, vice-president of Piasecki Helicopter Corp.

Gas Turbine-Propeller Powerplants Predicted For Commercial Use as Members Visit GE Lab

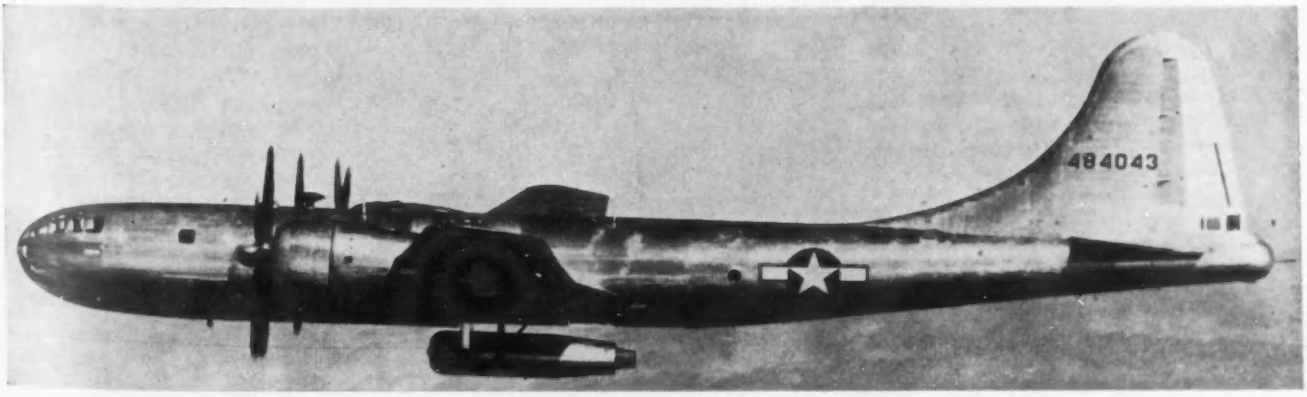
by GENE O'HAIRE, Field Editor

MOHAWK-HUDSON Group, Oct. 12 – SAE members from Schenectady, Albany, and Troy attended this Group's October meeting held at the General Electric Flight Test Center in Schenectady. Functions and purposes of the new Center were explained by David C. Prince, vice-president in charge of the company's general engineering and consulting laboratory, and C. G. Talbot, manager of the Flight Test Center.

Shown here is the B-29 Superfortress converted into a flying laboratory for the development and testing of all types of jet, gas turbine, radar and electronic aircraft equipment at the new Flight Center. The B-29 was loaned to G.E. by the AAF for experimental purposes. Suspended from its bomb bay doors is the torpedo-shaped axial-flow turbojet engine developed to drive military and civilian planes at great speeds on long flights. The new Center will be opened officially in June with a national air research demonstration.

Jet propulsion tests which engineers and designers say will lead to revolutionary changes in two-thirds of all future aircraft are among the Center's main projects, Prince told the visiting SAE members. Engineers, he said, have predicted low-priced private planes of reasonably high economy, powered by gas turbine-driven propellers. They also predict large commercial and passenger lines will use planes powered by gas-turbine propeller powerplants.

GE's B-29 Flying Laboratory



Trolley Coach Has Special Niche in Today's Traffic

by W. F. SHERMAN, Field Editor

DETROIT Section, Nov. 4 – The place of the trolley coach in the modern transit system was clearly set forth by Charles Guernsey, vice-president, Marmon-Herrington Co., Inc., at the November dinner meeting of the Detroit Section.

Time and place of this discussion were considered particularly appropriate because Detroit is one of the nation's major cities facing a difficult mass transportation problem.

"The average automobile carries 1.7 seated passengers," Guernsey said, "The modern trolley coach or large bus will carry 44 seated passengers. Counting necessary headway in a traffic lane, the automobile will take about 25 times as much street space per passenger as a large public carrier vehicle. The problem is one of moving people, rather than one of moving vehicles."

Assigning the street car to operation on heavier lines in large cities, and buses to suburban areas and applications where considerable flexibility of route is involved, he declared that "in between, there is a very broad field where trolley coaches can serve better than either bus or streetcar with more satisfaction to the public, better schedule performance and lower operating cost."

The modern trolley coach awaited engineering progress which included the following:

1. A self-supporting, side-wall-stressed vehicle body without separate chassis.

2. Development of large-capacity balloon tires in adequate sizes.

3. Development of the modern automotive air brake.

4. Development of suitable lightweight, high-speed electric motors with appropriate control.

The first modern vehicles approaching these specifications were built in 1928, and about 3500 were in service at the beginning of the war. An additional 3400 have been ordered since the war.

The vehicles, carrying 44 seated passengers, are powered with a single 140-hp, 600-v d-c motor, either of the series or compound wound type.

"The electrical equipment is usually arranged to provide a limited amount of electrical braking, generally at a rate of about 2 mphps," Guernsey said. "During accelerating and during braking various resistors are cut into the circuit. These resistors are normally housed and arranged for forced draft cooling by means of a blower. The heat generated can be blown overboard or delivered inside the vehicle for heating purposes as determined by the position of a damper controlled by a thermostat.

Acceleration and braking are controlled by two pedals operated by the driver's right foot, usually of the flat or organ type pedal. Electrical control equipment is automatic, providing an acceleration rate determined by current limit control, but subject within this limit to lower rates established by the pedal position under control of the driver. Maximum accelerating rate is determined by what the standing passenger can tolerate. Most operators set the maximum rate at 3½ to 4 mphps.

Because they are intended primarily for heavy duty lines, trolley coaches are normally made heavier and more substantial than motor buses of the same size. Weights vary from 17,000 to 23,000 lb.

Guernsey showed slides illustrating modern trolley coaches made by Brill, Pullman, and Marmon-Herrington. Included were cross-sections showing body and frame details and the duct work built into roofs to carry air for heating and ventilation.

The meeting was spiced by a talk by Chester S. Ricker, Detroit Section member, who is vice commodore of the Detroit Gold Cup Regatta Committee. He presented motion pictures of the Gold Cup Races Labor Day weekend on the Detroit River.

Coffee speaker at the dinner was Malcolm W. Bingay, columnist of the Detroit Free Press, who spoke on "Our Changing World."

At the meeting the SAE Council, through L. Ray Buckendale, president, presented a piano to the Engineering Society of Detroit in appreciation for the use of the Rackham Building meeting rooms through the entire war period by the SAE War Engineering Board. James C. Zeder (W.E.B. chairman) accepted for ESD, of which he currently is secretary.

CLOSING DATE

SAE Journal strives, in these pages, to bring to Society members live, prompt news coverage of every Section meeting. Material is provided by section field editors.

With dates determined by printing schedules, this issue covers all Section meeting news received in New York up to Dec. 15.

Diesel Developments, Requirements Examined

by ARNOLD R. OKURO, Field Editor

NEW ENGLAND Section, Nov. 12 – Over 87 members gathered at the Engineers Club tonight for a diesel meeting arranged by Lewis B. Ebbs, vice-chairman for Diesel Activity.

Coffee speaker W. G. Perriguey of Standard Oil Co. of N. J., discussed the requirements of fuels and lubricants for high-speed diesel engines, and accomplishments in this field resulting from cooperative and chemical research. S. B. Tuttle of General Motors Corp.'s Detroit Diesel Engine Division explained the features involved in direct injection, pre-chamber and Lanova designs, and contrasted the differences in a number of various-make engines.

Focus on Fuel Pump For Greater Savings

by ARNOLD R. OKURO, Field Editor

NEW ENGLAND Section, Dec. 3 – Considerable postwar glamor has been focused on roundabout ways of improving fuel consumption . . . through fluid transmissions, dual carburetion, and injection systems. But results have not been impressive, William J. Burns of Carter Carburetor Corp. told this meeting.

Suggesting fuel pumps as the more logical point of attack, Burns emphasized performance advantages of Carter's mechanical fuel pump. Improvement is credited to:

- A one-piece diaphragm, with the engine side protected from attack by crankcase oil and temperature.
- Increased volume, permitted by an increase in valve capacity.
- A new finish to discourage the decomposition of alloy castings.
- A delivery pressure of 5 psi, with the pulsation damped out by an outlet diaphragm of resilient material.
- A simplified linkage using a C-channel arm of unusual strength.

Despite the efficiency of any mechanical pump, Burns said, its utility always is limited by the possibility of vapor lock derived from engine overheating.

BRUCKLACHER

Williamsport

Albert L. Brucklacher, Williamsport Group chairman, is known by all of his many friends as "Pete" and he is noted for his amiable personality and ready smile for any occasion.

Born and raised in Williamsport, "Pete" received his formal education at the Pennsylvania State College. Returning to Williamsport in 1936, he entered the engineering profession by doing design work for the E. Keeler Co., manufacturer of steam powerplants, for several years.

Since 1940, he has been a service engineer with the Lycoming Division of the Aviation Corp. "Pete" specializes in service publications, handbooks, and in conducting tests and experimental work in connection with engine troubles for the purpose of preparing service bulletins.

Albert L. Brucklacher

He is noted for tricky camera shots clearly illustrating complicated service procedures concerning the overhaul and assembly of aircraft engines.

His hobbies consist of motor-boating and playing bridge and chess. At the present time, his chief hobby seems to be interior decorating, since he was married recently and was lucky enough to obtain an apartment.

He joined the SAE in 1944, and credit must be given him for organizing the SAE members in this area to form the Williamsport Group in 1945. The group members are confident that their first chairman is a competent leader. – by Robert Ingram, Field Editor.

WIEBE

Peoria

Dr. Richard Wiebe, Peoria Section's chairman, is head of the Motor Fuels Section of the Northern Regional Research Laboratory, Department of Agriculture. His work is concerned largely with the derivation of motor fuels from agricultural products and byproducts, and he is a frequent contributor to scientific journals on such topics as the thermodynamics of fuel-air mixtures as applied to internal combustion engines.

He received his BS in chemical engineering from the University of Utah in 1923, and three years later took his PhD in physical chemistry at the University of California.

His first job was with the Bureau of Mines in Pittsburgh, working on the separation of natural gas from helium. In 1928 he went to the Bureau's helium plant at Amarillo, Texas, to take charge of low temperature research. Two years later he went to Washington, D. C., as head of the high pressure work at the Fixed Nitrogen Research Laboratory. In 1940, when the Department of Agriculture established its Regional Research Laboratories, Wiebe was one of the first men to come to the Peoria Laboratory.

Richard Wiebe

Among his hobbies are hiking, swimming, and history, and he is also known as a gardener who gets Results. He is married and has two sons, one in college and one in high school.

His unflagging interest in the promotion of SAE affairs is reflected in the constantly widening circle of members and the increasing interest aroused by Section meetings.

by E. S. TOMKINSON, Field Editor

WILLIAMS

Syracuse

Elected to SAE in 1945, John D. Williams was made vice-chairman of the Syracuse Section for the latter part of the 1945-46 season when resignation of the chairman automatically elevated the previous vice-chairman. In further recognition of his likable personality and management ability, he was elected chairman of the Section for the 1946-47 season.

A native of Utica, John Williams received his public school education in that city and his technical education at R.P.I. and Pratt Institute.

John D. Williams

He returned to Utica to work for Savage Arms Corp. He was in charge of the time study and rate setting department at Savage, when in 1930 he secured a position with W. C. Lipe, Inc., in Syracuse. Joining this firm at a time when its new owner, H. F. Hodgkins, another former Savage employee, was transforming the business from that of a job and experimental machine shop to a production type shop, Williams found many duties from purchasing the raw material to selling the finished product.

As this firm grew and developed new products, John Williams remained with it – and today is vice-president and general manager of the successor corporation, Lipe-Rollway Corp.

A Rotarian since first coming to Syracuse, he has also taken an active part in the local manufacturers' association.

Having built a house on the edge of a golf course, he is a member in self-defense to make sure the club maintains the special screens they furnish to protect his windows. Of course, he does play golf there, too.

John is the father of a son now at West Point, after having served several months in the Navy prior to the end of the war, so John is now betting on the Grey.

His most joyous diversions are bowling with the Lipe-Rollway teams each week and acting as master of ceremonies at company parties. – by C. W. Simmons, Field Editor.

This is the fourth installment in a series of biographies of 1946-47 SAE Section chairmen. Next month three more field editors will report on their Section chairmen.

Light-Weight, High-Output Aircraft Engine Described

by E. S. TOMKINSON, Field Editor

PEORIA Section, Nov. 25 – The internal combustion engine is one of the most complex fatigue machines ever devised, W. T. Bean, Jr., told this meeting. High cyclic loads pose many problems for designers. But experimental stress analysis provides a previously unavailable tool for the solution of these problems.

Bean described, as an example, the high output aircraft engine developed by Continental Aviation & Engineering Corp., where he is research engineer. This 2100 hp engine weighed only 0.79

lb per hp. In addition to passing its type test, it ran 13 hr at 90 in. of hg manifold pressure, giving an IMEP of 400 lb per sq in. and a maximum gas load on the piston of 37,000 lb. During its development, nearly every part of it broke at one time or another. Principle method used to search out failure causes was the convenient, quick, and inexpensive stresscoat technique, sometimes used in conjunction with strain gages.

Stresscoat was used in crankcase diaphragm failures to locate points of stress concentration, found to be in the deep thin ribs of the magnesium casting. Ribs were made lower in height, and removed material was used to increase fillet radius and to provide increased thickness at some points. End result was a redesigned crankcase, lighter and at the same time actually stiffer.

Textbook values for strength of light alloys must be taken with a grain of salt, Bean said. Actual critical loads must be known for the particular part involved, and these loads often can be found much more quickly and cheaply by static than by dynamic tests. Tests on the actual part rather than on a sample of the metal evaluated all manufacturing factors including residual stresses and production methods.

Optimum endurance of any part depends on three factors: design, material, and processing. With average design, using good material but poor processing, only about 10% of the potential endurance will be realized. Using average design with good material and good processing will realize about 50% of this potential.

A series of slides of the 2100 hp, 1650 lb inverted V-12 engine illustrated the paper, and Bean also had available some actual engine parts including pistons, a connecting rod, and two sections of the magnesium crankcase.

SAE Hears Saga Of Gasoline Research

by H. F. TWYMAN, Field Editor

KANSAS CITY Section, Nov. 18 – This Section heard Dr. C. D. Lowry, Jr., present a comprehensive survey of gasoline improvements during the last 25 years. He pointed out some of the important problems marked out for research 25 years ago, and described advances made during this quarter-century:

- Increased use of continuous treating equipment.
- Increased use of fractionating columns on stills, and elimination of redistillation and distillates from crude oils.
- Development, improvement, and increased use of cracking processes.
- Study of the nature and distribution of sulfur compounds in petroleum.
- Standardization of analytical methods.
- Development of higher efficiency in internal combustion motors through use of selected fuels or through use of chemically treated fuels which will stand higher compressions.
- Determination of specific heat and vapor pressures of petroleum oils for design purposes.
- Advances in knowledge of gum formation causes, advances in treating and in knowledge of inhibitors.
- Use of catalysts to facilitate production of higher hydrocarbons from petroleum.

T&M Experts Examine Wide-Base Tires, Rims

by C. F. FOELL, Field Editor

METROPOLITAN Section, Nov. 21 – Unlike Topsy, wide-base tires and rims didn't "just grow." Their advent and development were the result of considerable planning from the start. Unfortunately, standardization has proceeded slowly, so that vehicle operators as a group have been very much in the dark about this subject.

With these thoughts as a basis, speakers at this meeting discussed the history of the wide-base tire and rim, its technical features, present degree of standardization, and the impact on both the vehicle manufacturer and user. The four-man symposium consisted of George M. Sprowls of Goodyear Tire & Rubber Co., and W. S. Brink of Firestone Steel Products Co., who reviewed the question from the manufacturers' standpoint; R. B. Wuerfel of Chevrolet Motor Division, GMC, representing a vehicle manufacturer; and Emil Gohn, Atlantic Refining Co., representing the users.

Messrs. Sprowls and Brink emphasized these advantages of wide-base tires and rims:

1. Mileage increases of 15 and more percent are usually assured;
2. Lower tire temperatures, at times as much as 50F below normal, have been attained;
3. Greater tread flatness and hence improved road contact;
4. Fewer blowouts and carcass failures;
5. Improved vehicle performance due to greater tire stability; and
6. Consequently, reduced vehicle operating costs.

Technical data presented show that optimum rim-width ratio (distance between rim flanges/tire cross-section at normal pressure) is about 70%. Standards set up by Tire and Rim Association specify 10 tire sizes, each with its specific rim; tire sizes range from 6.50 to 14.00 in., with rim widths starting at 5.0 in. and going to 9.0 in. by ½-in. increments, and then to the 10.0-in. rim size, the largest. Allowable flexibility in matching tire to rim is limited to the tire size next above the standard for a given rim width. No tire changes structurally are involved, but the rims are modified from existing practice to provide better support for the beads and sidewalls, and to reduce the great number of rim sections now in use.

Wuerfel stated that vehicle manufacturers have to consider both the economic and technical aspects of the problem. Where the economics are right, use of the wide-base idea can be pursued, since studies to date show no appreciable technical obstacles. Steering gears are adequate, as is the steering geometry; greater toe-in has been found advisable. Some redesign may be necessary to place wide tires on very small trucks, and dual jobs for large trucks may be impossible in some instances when the overall width is increased beyond the normal 96 in.

Gohn, citing limited surveys to date, presented evidence to support the advantages listed above. Some of the mileage increases reported were well beyond the 15% mentioned, reaching the amazing figures of 32 and 40% in two cases.

The meeting was arranged by Howard Pile, Met Section's vice-chairman for T & M Activity. John F. Creamer, president of Wheels, Inc., and also president of Tire and Rim Association, acted as technical moderator.

Combustion Films Stimulate Questions

by ROBERT B. INGRAM, Field Editor

WILLIAMSPORT Group, Dec. 2 – Stating that his "time microscope" or 200,000 frame per sec camera is so fast that a jet propeller airplane flying 500 mph would require about 10 min to fly its own length, C. D. Miller of NACA introduced his widely-presented paper before the Williamsport Group.

Before presenting his two-reel motion picture film on knock, Miller brought out that early nigh speed cameras such as developed by A. M. Rothrock (2000 frames per sec) showed only the autoignition portion and not the "detonation waves" that often occur during knocking combustion.

The two reel film presented was the same as that first shown at the SAE summer meeting on June 5, 1946 at French Lick. High-lights of this film showed that:

a) Knock can be caused from autoignition, detonation waves, or by a combination of both.

b) Autoignition can occur without the presence of detonation waves; in

concluded on p. 103

News...

...OF THE SOCIETY

San Diego Is New Section

THIRTY-FIRST SAE Section is the new San Diego Section, affirmed Dec. 3 by Council at a meeting in Chicago. The group had been a part of Southern California Section, and was known as the San Diego Division of the Section since 1940.

Embracing San Diego and Imperial counties, membership of the new Section is approximately 100.

Appointed by Southern California Section Governing Board as temporary officers, the new Section Board will work under the direction of Frank W. Fink, chairman; J. H. Farnme, vice-chairman; D. R. Thomas, secretary-treasurer; Robert C. Gross, chairman of the Membership Committee; Henry Mandolf, chairman, reception committee, and F. H. Sharp, Meetings Committee chairman.

Besides the 31 Sections, there are also seven SAE Groups throughout the United States and in British Columbia.

SAE Thanked by AAMVA For Amputee Driving Aids

A VOTE of appreciation has been extended by the American Association of Motor Vehicle Administrators to the SAE for valuable assistance received from the Society's report "Vehicle Control for Disabled Veterans."

At the request of AAMVA in 1944 to develop mechanical aids to permit as many handicapped veterans as possible to drive, the SAE developed several "pilot" model automobiles, each of which was equipped with a complete set of driving aids. Devices were designed to permit selection of the proper equipment for the specific disability of the veteran.

Utility of these SAE-developed devices was demonstrated by veterans at the Walter Reed General Hospital on July 11, 1945. Among the items of special equipment developed were a steering wheel knob to be used with artificial hands, steering wheel throttle and brake levers that eliminate foot operation of brake and accelerator, automatic clutch, and a hill-holding device connected with the brake and clutch.

These devices were designed so as not to interfere with normal operation of the car.

SAE War Engineering Board's technical committee, which developed these devices, was chairmanned by L. A. Chaminade, Chevrolet Motor Division, GMC.

Adds T&B Activity

COUNCIL approved on Dec. 3 the addition of a Truck & Bus activity for the Philadelphia Section. The Section has an Aircraft, Fuels & Lubricants, and a Transportation & Maintenance Activity. The Philadelphia Section Governing Board will name a vice-chairman for the new activity, and this post will be included on the Section's ballot hereafter.

T&M and T&B Join In Chicago Meeting

SOMETHING new in SAE National Meetings has been added. Council approved on Dec. 3 a joint Transportation Meeting, April 16 to 18, at the Stevens Hotel, Chicago.

Because of the interrelationship of most vehicle operating and design problems, the Transportation & Maintenance Activity invited the Truck & Bus Activity to join in sponsoring a joint meeting, replacing the 1947 National T & M Meeting. The invitation was accepted by the T & B group.

The Meetings Committees of the two Activities have already begun working on program and other plans for the Chicago Transportation Meeting.

Hunt on ASA Board

APPOINTMENT of SAE Past-President John H. Hunt by President L. Ray Buckendale to the board of directors of the American Standards Association was approved Dec. 3 by Council.

A member of the Society for the past 30 years, Hunt served for many years on the General Standards Committee which he headed since 1938, and has been active on several important SAE technical committees as well as administrative groups of the Society. He is a member of the SAE Technical Board.

Student Branch News

College of the City of New York

The jet engines are making supersonic flight possible today, members of the SAE Branch of the City College of New York were advised by Lovell Lawrence, Jr., Reaction Motors, Inc., at the Nov. 20 meeting of the Branch. At flight speeds of 500 mph or less, however, the pure jet engines show much inferior efficiencies to the conventional reciprocating engine and their use is not justified.

The pulse jet, Lawrence announced, as exemplified by the German V-1 buzz bomb, is momentarily being used by the military to power guided missiles in the subsonic speed range but has potentialities for supersonic speeds. The ram jet is limited to extremely high speeds in an atmospheric medium and its development is being over-

shadowed by the fast-paced exploration of rocket power.

Rocket power plants, free from dependence on atmospheric oxygen, have lately been used to propel flying laboratories into the stratosphere. The German V-2 flying bomb reached speeds of over 300 mph and there is ample reason to believe that trans-oceanic rocket flight will be possible before long. The tremendous amount of energy rockets develop with relatively simple and light equipment has made them useful for aircraft takeoff applications. Lawrence suggested rocket assist in an autogiro to give it the same flexibility as the helicopter.

Detroit Institute of Technology

During the month of November the members of Detroit Institute of Technology, SAE Student Branch, visited two of Detroit's industrial establishments.

One of these was the Parker Wolverine plant, a subsidiary of Utilite Corp. This plant is engaged in manufacturing many automobile accessories such as bumper guards, license plates, brackets, and interior trimmings. Although the fullest degree of mass production is not utilized in the manufacturing of these parts, they are nevertheless turned out in great numbers.

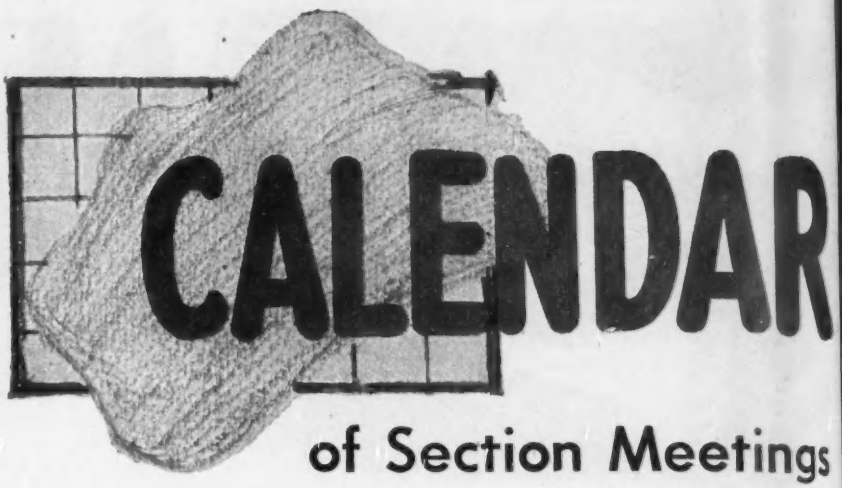
The other visits were made to the Ford Motor Co.'s Rouge and Dearborn plants. This was an all day inspection trip arranged through the efforts of Frank B. Lisowski, a senior student in the College of Chemical Engineering. The students met the company officials at Ford's famous Rotunda. They were shown the physical and chemical laboratories where the vendor's materials are being constantly checked. Besides the many laboratories, the group toured the different inspection stations dispersed throughout the plant. Following this, the group toured the Aircraft Building used for manufacturing of Pratt and Whitney Aircraft Engines during the war.

Fenn College

The Fenn SAE Branch held its first meeting of the 1946-1947 School year on Nov. 15, 1946. Chairman Raymond F. Hitti announced that the Fenn Branch plans to make a field trip through the NACA Engine Research Laboratory in January. He also announced that the Engineering Paper Contest would end Dec. 9, 1946. The Chairman then presented the speaker sponsor, Thomas L. Kopke, a member of the Fenn Branch.

Kopke presented the guest speaker, Col. Donald Criston Fabel, Professor and Chairman of the Mechanical Engineering Department at Fenn. At the beginning of World War II Fabel, a Major in the Army Reserve Corps, was called into active duty. He was assigned to the Office of the Chief of

cont. on p. 93



Baltimore – Jan. 9

Engineers Club; dinner 7:00 p.m. Postwar Carburetors and Fuel Systems – William J. Burns, field service engineer, Carter Carburetor Corp.

British Columbia Group – Jan. 8

Hotel Georgia, Vancouver; dinner 6:30 p.m. Diesel Engines – C. R. Jones, Cooper-Bessemer Corp.

Buffalo – Jan. 17

Westbrook Apts., dinner 7:00 p.m. New Rear Engine Streamlined Car – Preston Tucker, president, Tucker Automobile Co.

Chicago – Jan. 20

Hotel LaSalle, South Bend; dinner 6:30 p.m. Automatic Transmissions – Robert Lapsley, development engineer, Clark Equipment Co.

Cincinnati – Jan. 12

Hotel Alms, dinner 6:30 p.m. Diesel Engines in River Boats – John Ostborg, assistant chief engineer, National Supply Co. Motion Pictures – Boating on the Ohio and Mississippi. Steamboat on the River.

Cleveland – Jan. 13

Cleveland Club; dinner 6:30 p.m. Synthetic Lubricants – Virgil W. Ware, Rohm & Haas Co.

Dayton – Jan. 15

Moraine Products Division, General Motors Corp., dinner 6:30 p.m. 4:00 p.m. – Tour of Moraine Products Division. 8:00 p.m. Powder Metallurgy – R. P. Koehring, chief metallurgist.

Metropolitan – Feb. 4

Hotel Pennsylvania, New York; meeting 7:45 p.m. Navigational Aids in Air Transport – W. M. A. Burden, Assistant Secretary of Commerce.

Mohawk-Hudson Group – Jan. 21

Hotel DeWitt Clinton, Albany; dinner 6:45 p.m. The Importance of Steering Maintenance in Relation to Safe Operation of Automotive Vehicles – Roy F Nisonger and Charles Hines, Bear Mfg. Co.

New England – Jan. 7

Engineers Club, Boston; dinner 7:30 p.m. Present and Future Development of Tires – Mr. Carleton, Fisk Tire Co.

Peoria – Jan. 6

Jefferson Hotel; dinner 6:30 p.m. Detergent Oils – Ivan E. Howard, Phillips Petroleum Co.; Governors – George B. Grim, Caterpillar Tractor Co.; Fundamentals of Earthmoving – George H. Gearhart, Caterpillar Tractor Co.

Pittsburgh – Jan. 28

Webster Hall, dinner 6:00 p.m. Mellon Institute, meeting 8:00 p.m. Fleet Lubrication – Joseph M. Sills, Socony Vacuum Oil Co.

St. Louis – Jan. 14

DeSoto Hotel; dinner 6:30 p.m. XHJD-1 Helicopter – Its Purpose and Outline of a Future Research Program – C. L. Zakhartchenko, chief engineer, Helicopter and Jet Research Division, McDonnell Aircraft Corp. Motion Picture.

Southern California – Jan. 16

Biltmore Hotel, Los Angeles; meeting 8:00 p.m. Truck and Bus Meeting. Chairman – R. L. Koeppen. Speaker and subject to be announced.

Washington – Jan. 14

Hotel Twenty-Four Hundred, dinner 7:00 p.m. Research and Development of Automotive Equipment in the Field – Herman Levitz.

Wichita – Jan. 9

Airway Cafe, dinner 6:45 p.m. Aviation Oil Specifications and Ultimate Quality. Talk by local businessman. Motion Picture – Basic Principles of Lubrication.

Ordnance in Washington, D. C. Later he was promoted to lieutenant-colonel and made chief of the Artillery Division Sub-Office at Rock Island Arsenal. Fabel spoke on "Engineering Ordnance." He outlined three methods by which Ordnance equipment is improved: These methods are (1) The General Staff presents the problem to Ordnance, (2) The Research and Development Department of Ordnance proposes new or improved equipment, (3) The Industrial Division in charge of design, manufacturing, and production modifies and improves equipment as the result of field tests.

Massachusetts Institute of Technology

The M.I.T. Student Branch of SAE held its first meeting of the fall term at 5:00 p.m., Oct. 31, 1946. Charles Jordon was elected secretary-treasurer, to serve along with Thomas Zsembik, chairman, and Guido Frassinelli, vice-chairman.

Following the business meeting was a very informative talk by Prof. William R. Hawthorne of the Mechanical Engineering Department of M.I.T. Hawthorne demonstrated the relation between enthalpy and entropy in the Whittle engine turbojet.

Lawrence Institute of Technology

The first of several projects undertaken this term by SAE'ers at the Lawrence Institute of Technology was a trip to Greenfield Village, where the Edison Institute houses many of the forerunners of present day industrial developments. From a historical standpoint the trip to Greenfield Village proved especially interesting. The developments made in the interim, between early machinery and their present day counterparts, have hidden the basic simplicity of the earlier models.

The second event on this term's agenda was the lecture "What is a Fuel" delivered before Lawrence Tech SAE section by R. B. Sneed of Ethyl Corp. Utilizing lantern slides as a method for presenting the properties of fuels, Sneed was able to give a very informative lecture on fuels.

Plane Standards

cont. from p. 82

CAA. Qualified technical personnel from airplane and equipment manufacturers, airline operators, and the CAA will serve on the working committees. (How this new program will affect aircraft instruments was told in an article on p. 74 of the December, 1946, SAE Journal.)

The manufacturer of the part covered by the specification will be responsible for conducting the necessary tests to insure compliance with the specification. The CAA will accept the manufacturer's affidavit stating that such conformance has been demonstrated.

Amenable to this procedure are those affected including air carriers and manufacturers of all types of civil aircraft, electrical equipment, hydraulic equipment, instruments, wheels, brakes, fasteners, and radio equipment.

Change Hailed by Industry

Attitude of industry toward this new arrangement was summed up by A. E. Raymond, Vice-President of Engineering of Douglas Aircraft Co., at the SAE National Aeronautic Meeting, on October 4, when he said: "The net result can be a straightforward and nonrestrictive approval system that will adequately fill the needs of all parties. . . . Further, technical advancement in design of these products will be fostered by a system of industry-controlled performance standards where new developments can be incorporated readily."

Aero Drafting Report

cont. from p. 85

that all activity under its wing might well render a greater service by presenting as uniformly as possible all drawings issued. There is bound to be some difference in drawings with 39 committees and many sub-committees preparing specifications, information reports, recommended practices, and standards in the aeronautic field.

The report supplements the SAE Aeronautical Drafting Manual. It specifies the type of lettering to be used and states that dimensions should not be given in fractions; A number of general rules also are contained. Committees are advised that all drawings should be kept within a 7.50-in. x 9.00-in. area on the standard printed sheet; that machined parts such as bolts should be shown in the position in which they are usually fabricated; that a standard tolerance note for linear and angular dimensions shall appear in the lower right hand corner of the drawing; and that abbreviations and symbolized notes conform with those indicated in the SAE Aeronautical Drafting Manual.

Considerable progress also has been made by Aeronautical Drafting Manual Committee, S-1, on refinements slated for the Manual. Among them are the interpretation of aeronautical drawings, tolerances and fits, and springs.

Efforts are being directed toward development of a revised section on definitions to clarify commonly misunderstood or controversial terms, symbols, and notes. Aim of the Committee here is not to compile a dictionary of every conceivable term used in preparing aeronautical drawings, but to define and clarify, by sketches if necessary, those ambiguous terms subject to two or more possible interpretations.

A case in point is the designation of chamfers. As shown in Fig. 1, size of the chamfer specified by the note is the length of the adjacent sides of the material removed, not the length of the hypothenuse or flat. All chamfers other than 45 deg must be fully dimensioned, says the Committee.

Another instance where engineers

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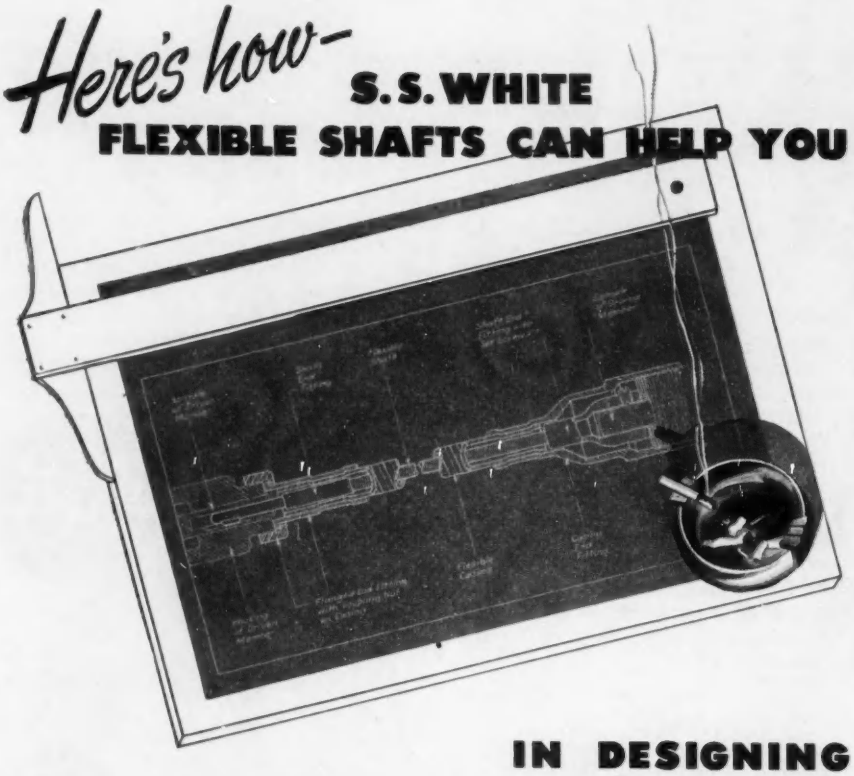

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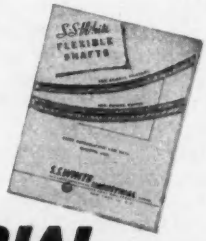

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and draftsmen are confused is in interpreting the meaning of "full indicator reading" as regards tolerances of finished surfaces. A Note saying "within 0.010 F.I.R. (full indicator reading)" means ±0.005. Erroneously interpreting this as ±0.010 – which denotes a F.I.R. of 0.020 – is quite common.

The project on springs is intended to expand that section in the Manual. A recommended practice is being prepared covering tension, torsion, and flat springs to supplement the one on compression springs already in the Manual.

Another proposal taking shape is the addition of a section on tolerances and fits in the Manual. Committee Chairman O. E. Kirchner, of American Airlines, Inc., advises that recent discussion and review of this project points to a patterning of both the ASA and Army Ordnance practice on tolerances and fits.

At the last meeting a number of members raised the question of the desirability of continuing to specify pitch diameter on drawings. They felt that it was not feasible for high production shops. Majority opinion held that the Committee should stick by its guns and continue to recommend specifying of pitch diameter, since aircraft today are built in comparatively low volume quantities.

Although Committee S-1 finds itself in the midst of an unusually active program, many projects on the agenda are yet in their infancy.

Will Rate Batteries On Service-Type Load

EASIER-TO-USE battery ratings being formulated by the SAE Storage Battery Subcommittee for inclusion in the SAE Handbook will tell how effective the battery will be in service.

In addition to new battery types (See October SAE Journal, p. 84, for details), the Subcommittee is working on a new rating for the battery classification table. It will rate the battery on the number of hours current will be delivered at the rate of 25 amp at 80 F at 1.75v per cell.

Members of the Subcommittee feel this rating will be most useful to both the average vehicle operator and manufacturer since it simulates battery performance under vehicle connected load. In other words, it tells how many hours a new battery can be expected to operate in a car under normal load such as lights, heater, and radio should the generator fail to charge the battery.

Another project under way is a revised and expanded section for the

SAE Handbook detailing procedure and equipment for the storage battery 20 hr discharge test. Chairman F. A. Franklin, GMC Truck & Coach Division, reports that this new section will describe the test procedure step-by-step and show schematic diagrams of the test equipment and switchboard circuit. Type of equipment needed and instructions on assembling the test apparatus also will be included.

On the Subcommittee's long range agenda is an item that indicates future batteries will be subjected to more rugged tests. Tests will be conducted to determine battery discharge rate at —20 F. But until such time as the —20 F rating is developed, the minimum time for 300-amp discharge at 0 F will continue to be specified.

Aircraft Ignition

cont. from p. 73

First is a suppressor – a resistance-inductance network – connected across the primary magneto circuit. Energy available from standard aircraft magnetos is higher than that required for low-tension ignition. Also the normal oscillation time of magneto circuits is longer than necessary. The suppressor permits normal operation of the magneto until the spark occurs, then quickly suppresses the circuit to damp out residual oscillations before they can interfere with formation of the next spark.

Second item of interest is the pickups that permit observation with an oscilloscope of the voltage to each converter as well as identification of each pulse with the engine cylinder number.

That this ignition system offers many advantages already has been proved. Once its design is adapted to practical production techniques, it will become available to the aircraft industry. (Paper entitled "High-Frequency Aircraft Ignition System with Low-Tension, Low-Frequency Distribution," presented at the SAE Indiana Section, Nov. 8, 1945.)

Air Transport Meeting

cont. from p. 59

The old fashioned, rugged passenger who was content with discomfort as long as he got where he was going is disappearing percentagewise, A. P. Elebash, Pan American World Airways, told the audience. Top of his list of passenger needs is a good comfortable seat. Not only should the seat be adjustable to fit people of different sizes and shapes, he recommended, but work should be done to develop seats that could be fastened in various positions to suit the desires of groups of passengers.

"In a plane load of 50 passengers, we can expect two or three children, a baby or two, a couple of aged, several with heart trouble, possibly a bed patient, numerous passengers with colds or sinus trouble, two or three of very low socio-economic status, a movie actress, a drunk, an engineer, and an obnoxious character or two.

"These we crowd into a cabin with floor area only as large as that of a large living room, stir well, and apply heat. Soon something happens," he said.

Discussion, directed by Session Chairman W. C. Mentzer, disclosed that a fertile field for interior decorators lies in cabin design of tomorrow's airlines, and that considerable basic work is to be done to meet the air passenger's demands.

Posing the possibility of underground servicing installations as a method to overcome aircraft loading and unloading congestion, E. S. Hamm cited the

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increased congestion at airports the country over.

Remedy for Congestion

The Northwest Airlines, Inc., engineer reported increased mechanized handling of cargo, but suggested that passengers carry their own baggage aboard and from airplanes. Discussion pointed to extensive coordinated study of this problem by the Air Transport Association of America, particularly with respect to standards of door heights and sizes, and other basic engineering phases.

The afternoon session, conducted by SAE Vice-President Charles Froesch, threw new light on this question when W. L. Flinn suggested building some of the ground equipment into the airplanes themselves. The Capital Airline engineer listed surface control locks, auxiliary power source, nose cargoveyor or loading steps, tail cargoveyor, passenger steps, tail pedestal, double safety L. G. locks, underwing fueling and oiling fittings, and air conditioning facilities be built into the plane.

Except for occasional reports of dramatic rescues at sea and on land, few know of the yeoman service of the helicopter during the war, Edward Nesbitt said. He estimated that the total flying time of this type of craft has reached the astonishing figure of 45,000 flight hr, or about 2000 times the length of the equator – a figure approaching 5,000,000 miles.

Failure of the helicopter to achieve the generally predicted family flying from backyard airports was laid to delays in mass production which in turn could reduce the first cost of this type of craft, but the Sikorsky Aircraft engineer declared that well designed helicopters perform as predicted.

More than 12,000 sorties were flown by the British during the war, and important use was made by them to calibrate radar detectors in England's anti-aircraft battles. They were valuable time savers in making ship-to-shore contacts in the Pacific, carrying needed parts to shore from Liberty ships laying offshore under the horizon.

As feeders for airlines, and for mail routes the helicopter has a great future in this country, Nesbitt believes.

Jules Verne would have enjoyed Tuesday evening's session as much as did the audience when Chairman Harold Hoekstra introduced three speakers on landing and launching transport aircraft from moving land vehicles, jet assisted takeoff for transport aircraft, and airborne aircraft arresting gear.

L. A. Rodert, speaking for himself and not the National Advisory Committee for Aeronautics, suggested that the time has come for the air transport industry to study the question of using a specially built railroad car to launch and land air liners.

He pointed out that higher cruising speeds which will be commonplace when jets and turbo jets are used to power transport planes will demand higher landing and takeoff speeds, putting excessive burdens on landing equipment.

Visualizing a five to seven year research program, Rodert said he was introducing the subject to determine the air transport industry's interest in such a project. He felt that radar homing devices would help in landing and launching.

Wheel-less Planes Proposed

Pending further study, he also felt that the concept of aircraft would have to be altered. For example, without landing gear and wheels, the bottom of the aircraft should be much stronger than is today's design, and serve as the hull for emergency crash landing on water and land.

Jet assisted takeoff is practical for air transport and examples of such were shown in a film in Capt. William L. Gore's presentation of E. E. Nelson's paper. Developed during the war, JATO is moving into commercial applications. The Aerojet Engineering Corp. is de-

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veloping a smokeless material for the rockets, thus removing an objection cited by a number of engineers during the discussion.

A rocket in the tail of a plane, with a cable and then a length of a plastic material known as unolyn attached to another length of cable and fastened to the plane, was a device described, with a moving picture, by A. B. Schultz. "There is no engineering reason to prevent its use in transport planes, but an obvious difficulty would be to drive the rocket spike into concrete of a modern landing strip," the chief engineer of All-American Aviation, Inc., told his startled audience.

Energy is dissipated through the molecular juxtapositions caused by stretching the material. Unlike a rubber band, the webbing of unolyn does not snap back to its former length but remains stretched to almost the length it is stretched.

Chairman A. L. Morse held a lively session Wednesday morning on the subject underwing refueling. A paper on the subject was read by H. O. Olson, who declared that test equipment has demonstrated practicability of using hydro-electronically controlled units to pump fuel into wing tanks from underneath.

Use of underground fuel lines was discussed at considerable length, disclosing two violently opposed schools of opinion. The speaker felt that, in view of congested airports, this would bring relief.

About SAE Members

cont. from p. 80

Twin Coach Co., Kent, Ohio, has elected **FRANK R. FAGEOL,** for many years president, to chairman of the board of directors.

ROBERT D. BUICK has been named an engineer of the Power Brake Division, Midland Steel Products Co., Detroit.

Formerly chassis engineer of Cadillac Motor Car Division, General Motors Corp., **WILLIAM E. BURNETT** is experimental engineer of Ford Motor Co.

ARTHUR DAWE is co-owner and operator of Alaskair, Anchorage, Alaska, aircraft and float repair establishment. He had been an aircraft mechanic with Pacific Northwest Airways in that city.

BENJAMIN ROSS ALSOBROOK, who resigned as field engineer of Wright Aeronautical Corp., has been named a staff engineer of Rohr Aircraft Corp., Chula Vista, Calif., manufacturers of aircraft powerplants.

Transferred from the Cincinnati plant, **CHARLES W. M. COOTE** is coordinator of production and engineering of Davisbilt Products Co., at the Long Island City, N. Y., plant of the company.

IAN G. DUNCAN has organized the firm Duncan Industries (Engineers) Ltd., North Walsham, Norfolk, England, which manufactures food processing machinery and does motor vehicle experimental work and machinery maintenance.

Resigning as tool engineer of Cleveland Pneumatic Tool Co., **TREVOR FINK** has joined McKinley Tool & Mfg. Co., Cleveland, in that capacity.

MILDRED SMITH has become an engineering assistant at Allis-Chalmers Mfg. Co., West Allis, Wis. She had been an SAE enrolled student at the University of Wisconsin.

Following service as a major in the Ordnance Department, **THEODORE JOSEPH HOLLENKAMP** has been named a contact representative of the Budd Co., Detroit.

ENSIGN ARTHUR G. BITZER, JR., is now an experimental engineer with Mall Tool Co., Chicago.

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Following his work in Michigan State College, **ROBERT C. FORMAN** is now an engineer with Sparta Division, Muskegon Piston Ring Co., Sparta, Mich.

JOHN V. KALB has been promoted from mechanical engineer to lubrication engineer by the Texas Co., New York City.

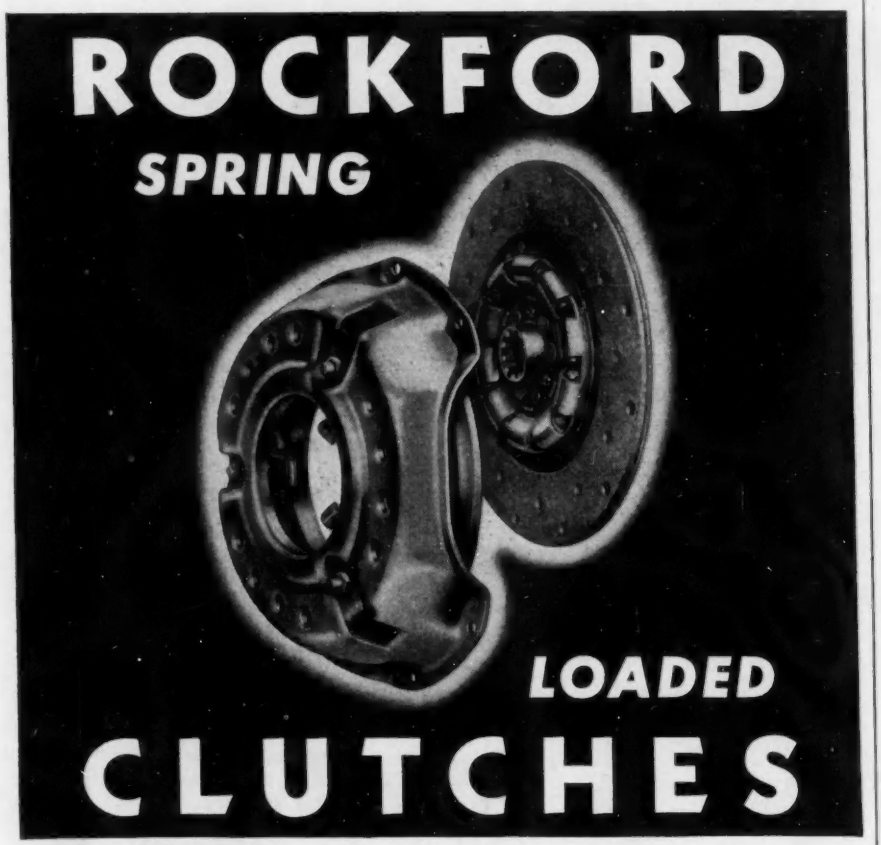
Until recently a research engineer in the Buffalo, N. Y., plant of Worthington Pump & Machinery Corp., **C. L. HILDEBRAND** is in the plant engineering department of Halifax Paper Co., Roanoke Rapids, N. C.

GERD H. GRIESHABER has joined the Electronics Division of General Electric Co., Syracuse, N. Y., as a mechanical draftsman. Since 1943 he had been with Aircooled Motors, Inc., first as assistant to the machine shop superintendent and later in the engineering drafting department.

Finishing his work at Cornell University, **SAMUEL W. MILLER, JR.,** has been named a research engineer for Glenn L. Martin Co., Baltimore.

Resigning from Continental Aviation & Engineering Corp., **WILLIAM R. MUNFORD** is a layout draftsman for Gar Wood Industries, Plant No. 1, Wayne, Mich.

ROBERT G. SMITH is a shop contact engineer for Curtiss-Wright Corp., Airplane Division, Columbus, Ohio. He recently completed service with the U. S. Army Air Forces assigned to Salina, Kans.



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CUSHIONED ENGAGEMENT
VIBRATION DAMPENING
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DIRT EXCLUSION
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LIFETIME ADJUSTMENT

* The cushioning spring arrangement between the facings in ROCKFORD Spring Loaded CLUTCHES provides cushioned engagement that enables smooth pick-up of the load, without grabbing or chattering. The springs maintain ample pressure to assure the required torque.

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Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD CLUTCH DIVISION BORG-WARNER
316 Catherine Street, Rockford, Illinois, U.S.A.

New Members Qualified

These applicants who have qualified for admission to the Society have been welcomed into membership between Nov. 10, 1946, and Dec. 10, 1946.

The various grades of membership are indicated by: (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate Member; (SM) Service Member; (FM) Foreign Member.

Baltimore Section: William H. Edmunds (A).

British Columbia Group: Percy W. Hawtin (A).

Buffalo Section: Jagannath Punnulal Chawla (J).

Canadian Section: Kenneth Clark MacAlpine Giffen (A).

Chicago Section: Frank F. Davis (M), Albert S. Kiefer (A), Everett M. Sandahl (J).

Cleveland Section: Lloyd L. Baldwin (M), Arthur Tregoning Cape (M), F. M. Falge (A), Robert W. Jones (J), Cearcy D. Miller (SM), Delavan S. Mussey (M), Edward R. Sharp (SM).

Dayton Section: B. B. Brombaugh (M).

Detroit Section: Lt.-Col. Charles M. Buhl (SM), Clarence G. Chambers (M), C. Robert Duncan (M), Woodrow W. Eargle (J), Peter Hay (A), Cornell Janeway (J), J. McGill Reynar (M).

Hawaii Section: John Sheehan (A).

Indiana Section: Ermil W. McMurtry (A), George E. Zorini (A).

Metropolitan Section: Edward Falkenstrom (J), Howard W. Frank (M), Russell W. Gregory (J), Charles S. Herrmann (M), Frank Budd Hineline, Jr. (J), Eugene J. Keenoy, Jr. (J), George E. Kellis (A), Allen H. Kent (A), J. Austin King (M), Carl M. Mueller (J), Peter O'Farrell (A), Clarence T. Pamp, Jr. (J), Milton P. Rashkin (J), Earle J. Raut (M), Abe. Ritterman (J), Major Lian-Tong Wen (FM), Frank H. Whaley, Jr. (A).

Milwaukee Section: Arnold F. Meyer, Jr. (M).

Mohawk-Hudson Group: Frederic P. Porter (M).

Northwest Section: B. J. Sears (A).

Oregon Section: George U. Benz (A), John H. Bollons (A), Jack H. Burns (J), John Curtis Heilbronn (A).

Philadelphia Section: Glenwoode P. Hacker, Jr. (J), Ernest Lloyd Korb (M).

Southern California Section: T. N. Baker (J), Robert O. Borst (J), Sydney B. Cook (A), Robert M. Francis (J), Bruce Fulton Grimm (M), Arthur Delafield Johnson (M), Philip M. Klauber (A), Benjamin Harrison Linville (A), Austin Clinton Porter (A), Don D. Remer (M), T. Claude Ryan (A), Raymond L. Seitz (M), Lt.-Comdr. John G. Sheridan (SM).

Southern New England: John J. Hospers (M).

Spokane Group: Dwight F. Hume (A).

Virginia Group: Joseph Michael Kelleher (A).

Washington Section: Luther M. W. Bolton (A).

Wichita Section: George C. Jehle (A).

Outside of Section Territory: Leon L. O'Dell (J), Carl Ray Stevens (J).

Foreign: Lt. John Robert Braham (A), England; Clifford Carr (FM), England; Anthony Churchill Elworthy (A), New Zealand.

Applications Received

The applications for membership received between Nov. 10, 1946, and Dec. 10, 1946, are listed below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

Baltimore Section: Wason M. Hyde, James Hamilton Owens, Jr., Earle Stewart, Robert Edward Younger, Jr.

British Columbia Group: David Main Ellen, Wallace S. Fairgrieve, George Mussallem, Leonard Norman Peace, Charles Albert Wood.

Buffalo Section: Julian D. Dickerson, Robert G. Lyon, Ralph E. Valentine, Jr.

Canadian Section: Gordon William Bouskill, J. Dawson Bunting, Jr., Alexander Sydney Gartshore, George Stewart Gray, Lloyd A. Hassell, Foster Cedric Hiran, Edwin Charles Tucker.

Chicago Section: Erwin W. Crane, O. H. Cunningham, Richard G. Cunningham, D. L. Davis, Jr., Edward K. Dombeck, Donald G. Ewing, William J. Hudson, Randall Wayne Johnson, Louis G. Kaplan, Frank George Mair, S. A. Malthaner, S. C. Massari, Howard Murray, A. Walter Neumann, James R. Renfrew, William E. White.

Cincinnati Section: Donald C. Fish, Earl Jackson, Alfred S. Jameson, Lape W. Thorne.

Cleveland Section: W. G. Bischoff, Jack M. Brown, Covel R. Jerauld, W. Douglas Jones, Frank H. Olton, Sydney C. Partridge, Marvin Clems Rigget, George Anton Vasicek, William Malcolm Walker, William B. Wier.

Dayton Section: Fred E. Crane, Donald E. Flinn, John H. Gerstenmaier, Richard F. Gompertz, Harold H. Haworth, Everett E. Rorer, William J. Schroeder, Joe Sherman.

Detroit Section: Charles Town Alexander, Donald G. Bay, George C. Best, Robert D. Cassell, Ronald B. Christian-

Engineered by Borg & Beck means...
PRODUCED TO INSURE MAXIMUM PROTECTION AGAINST NOISE, FRICTION AND WEAR
You can depend on—
BORG & BECK
FOR THAT VITAL SPOT WHERE POWER TAKES HOLD OF THE LOAD!
BORG & BECK DIVISION
BORG-WARNER CORPORATION
CHICAGO, ILLINOIS
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sen, William Sidney Coleman, Jr., James B. Darragh, Jr., Daniel P. Dyer, Jr., Wendell E. Faulk, Louis F. Freiberg, Louis T. Gerback, O. William Habel, Karl Veerin Holm, Jacob A. Jacks, Ray W. Jackson, Louis Joseph Jelsch, Hans C. Johnson, Michael Johnson, Jr., Richard T. Karr, Ross J. Kittle, Fred Klemach, Robert T. Lukens, Will Ruthven Meese, Hugh Douglas Lawrey, Walter S. Praeg, Walter N. Prokop, N. Markham Purple, John Joseph Smith, Ernest V. Smutek, Noel C. Speer, E. H. Stilwill, Leonard Augustus Young, Jr., Emil Zoerlein.

Hawaii Section: Bernard M. Schwalm.

Indiana Section: Edward P. Breneman, Jack D. Bryan, David M. Klausmeyer, Horace D. McCann, Fred Wellman.

Kansas City Section: Harden B. Elliott.

Metropolitan Section: Monroe Louis Bloomfield, Robert N. Campbell, Harry A. Conlon, Leonard W. Conrad, Edward William Eustace, Sidney Faden, Martin E. Felix, W. Welsh Godon, Gustave J. Hottendorf, John Michael Kavanagh, Lawrence B. McCloskey, Frank X. McCormack, John William Motzer, Joseph Nicholas Pecoraro, J. F. Sachse, Sol Silverman.

Milwaukee Section: B. L. Bobroff, Fritchof A. Fosdal, E. J. VanPatten.

New England Section: Malcolm E. Wallace, George F. Young.

Northern California Section: Esko A. Hofmann, Oscar Lee Johnston, Donald B. Macfarlane, Joseph DeWitt Sanderson, Ross B. Willoh.

Northwest Section: Runo W. Larson, Earl Eugene Phillips.

Oregon Section: John L. Hays.

Peoria Section: John Webster Gilbert.

Philadelphia Section: John M. Considine, William P. Dugan, George D. Greenly, Henry B. Griffing, Carl P. Nottingham, Allen W. Romig.

St. Louis Section: Edward H. Barker, John Paul Ekberg, Jr., Orval J. Lindell.

Salt Lake City Group: Lyle G. Garnas, W. C. Pierce.

San Diego Section: Neil S. Williamson.

Southern California Section: James E. Howry, Raymond Leon Page, Louis E. Rackley, Bernard Yancy Reins, Robert Nelson Yaeger, Jr.

Southern New England: L. Asadourian, Harry H. DeMuth, William C. French, Jr., Robert H. Gilpin, Alfred P. Godek, William J. Harris, Frank T. Sprogell, Jr., George B. Wallis.

Spokane Group: Victor H. Johnson.

Texas Section: Baity Bartel, William F. Funk, Lt. David Barnett McFadden, Penn E. Mullowney.

Twin City Section: Albert B. Driscoll, Robert P. Grafrath.

Virginia Group: Charles John Ahrens, Lloyd M. Dixon, C. M. Kastle, William W. Landram, Daniel Edwin May, George C. Valentine, E. H. Villemagne.

Washington Section: Chester R. Gurski, James L. Reardon, Morril Boughton Spaulding, Jr.

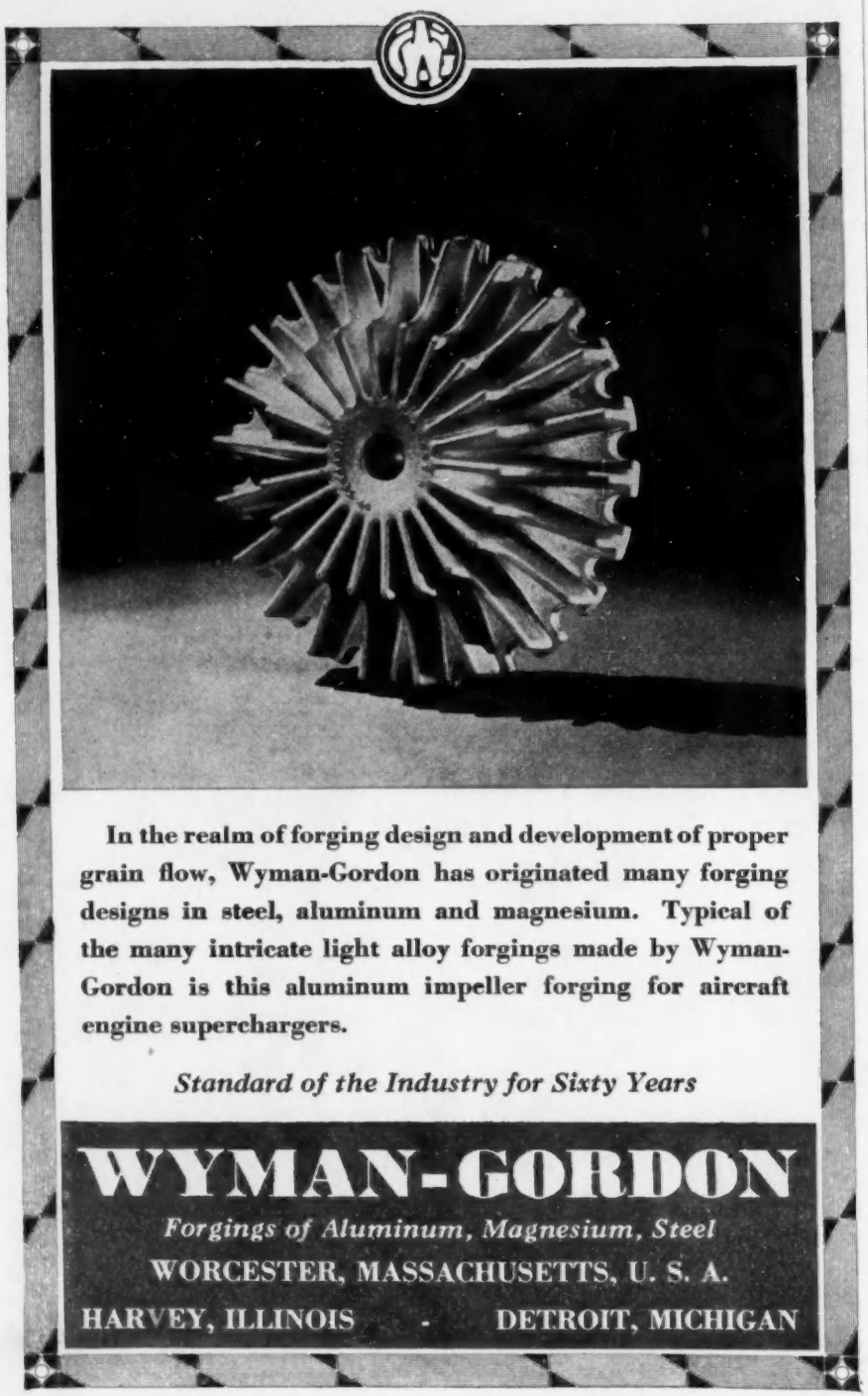
Western Michigan Section: C. Christy Jones, C. W. Lincoln.

Wichita Section: Joseph C. Funk, Frank Jezek.

Williamsport Group: Edmund George Pinger.

Outside of Section Territory: Charles Broyard, D. G. Forbes, David Jerome Hanse, Burton Lee Mills, Chris Nyberg, Russell F. Peete, Jr.

Foreign: Henri Emile Biraben, England; Kenneth Arthur Blacklock, Alfred Hector Blondel, France; Ralph Eckstein, Trinidad; Charles Harold Fisher, England; Robert Hardie, England; Lt. Mortimer Hulme Rigby, Japan; Cecil Stuart Roberts, England.



In the realm of forging design and development of proper grain flow, Wyman-Gordon has originated many forging designs in steel, aluminum and magnesium. Typical of the many intricate light alloy forgings made by Wyman-Gordon is this aluminum impeller forging for aircraft engine superchargers.

Standard of the Industry for Sixty Years

WYMAN-GORDON

Forgings of Aluminum, Magnesium, Steel

WORCESTER, MASSACHUSETTS, U. S. A.

HARVEY, ILLINOIS - DETROIT, MICHIGAN

Section News

cont. from p. 90

turn, detonation waves can occur without autoignition.

c) Detonation waves or "knock," travel at speeds ranging from approximately 3000-6800 feet per sec.

d) Autoignition may take several forms such as uniform ignition of the end zone gas throughout its entire volume, or "pin-point ignition" of the end gas at various scattered points.

A lively discussion period followed the presentation of the film with Mr. Miller answering questions on the construction of his camera, the effect of water injection on knocking combustion and the nature of radiation from the incandescent carbon released in the cylinder by the explosive knock reaction.

One question asked of Miller incited much discussion. He was asked whether he believed detonation caused excessive temperatures or pressures in the combustion chamber. "In my opinion," he replied, "explosive knock reaction as shown by my camera does not cause high temperatures or high average pressures." This was questioned by many since knock is known to cause a rise in spark plug gasket temperatures, and something must account for the piston failures that occur when an aircraft engine is operated at severe knock conditions.

Dayton Members Tour Steel Works

by JAMES E. P. SULLIVAN, Field Editor

DAYTON Section, Nov. 13 – Dayton Section members and their guests today made a guided inspection tour of American Rolling Mills Co.'s East Works. They watched ore and scrap being loaded into large open hearth furnaces, and followed the solid ingot while it was heated to a high temperature, worked by rolling, pressing, hammering and annealing, and finally saw the flat hot sheet snapped into a roll for shipping.

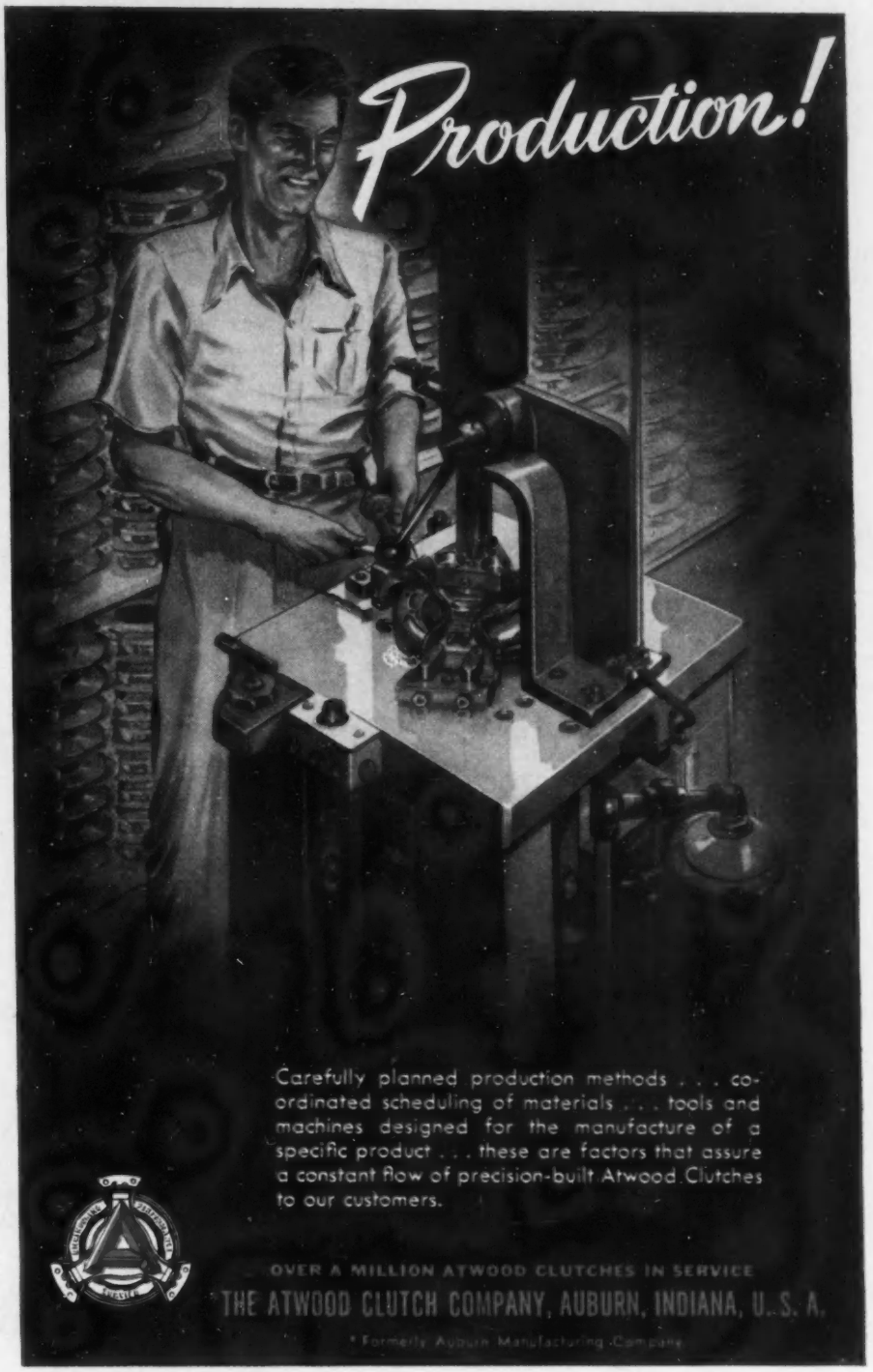
Car Styling Calls for Time, Talent, and Careful Planning

by C. E. BURKE, Field Editor

WESTERN MICHIGAN Section, Nov. 21 – From preliminary sketches to working drawing, automobile styling is intricate and carefully planned. Kenneth Coppock, director of the experimental and development section of GMC's Fisher Body Division, presented a talk on "Behind the Scenes of Automobile Styling" at this meeting.

Styling, he said, is necessarily worked out several years ahead. The stylist must be able to predict public tastes in advance. Some change in appearance is necessary each year.

New design begins with a group of sketch artists. Experienced designers go over sketches and combine the best ideas of each into a composite sketch. Sketch accepted, the next step is a 1/3-size clay model. From this and a full-size blackboard drawing with correct dimensions, a full-size clay and wood model is made. This is equipped with glass and paint and looks like the finished car. Engineering drawings are made after approval of the model, and from them the final wood and steel model, complete except for engine, transmission and hidden mechanism. The model is checked for visibility, leg room, appearance of instruments and other details. Approval of this model by executives means the start of production dies and the expenditure of huge sums of money.


Production!
Carefully planned production methods . . . coordinated scheduling of materials . . . tools and machines designed for the manufacture of a specific product . . . these are factors that assure a constant flow of precision-built Atwood Clutches to our customers.
OVER A MILLION ATWOOD CLUTCHES IN SERVICE
THE ATWOOD CLUTCH COMPANY, AUBURN, INDIANA, U. S. A.
* Formerly Auburn Manufacturing Company

Drop-wire undergoing abrasion tests in birch thicket "laboratory." Below, the new drop-wire, now being installed.

WE'RE GLAD THAT BIRCH TREES SWAY

The telephone wire which runs from the pole in the street to your house is your vital link with the Bell System. More than 17,000,000 such wires are in use.

The wire becomes coated with ice; it is ripped by gales, baked by sun, tugged at by small boys' kite strings. Yet Bell Laboratories research on every material that goes into a drop-wire—metals, rubbers, cottons, chemicals—keeps it strong, cheap, and ready to face all weathers.

Now a new drop-wire has been developed by the Laboratories which lasts even longer and will give even better service. It has met many tests, over 6 or 7 years, in the laboratory and in field experiments. It has been strung through birch thickets —rubbed, winters and summers, against trees, and blown to and fro by winds. In such tests its tough cover lasts twice as long as that of previous wires.

House by house, country-wide, the new wire is going into use. Wire is only one of millions of parts in the Bell System. All are constantly under study by Bell Telephone Laboratories, the largest industrial laboratory in the world, to improve your telephone service.

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